Power Engineering

MAY 1961

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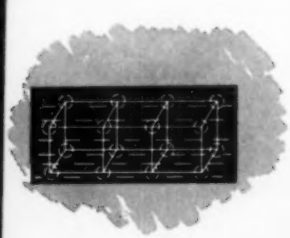

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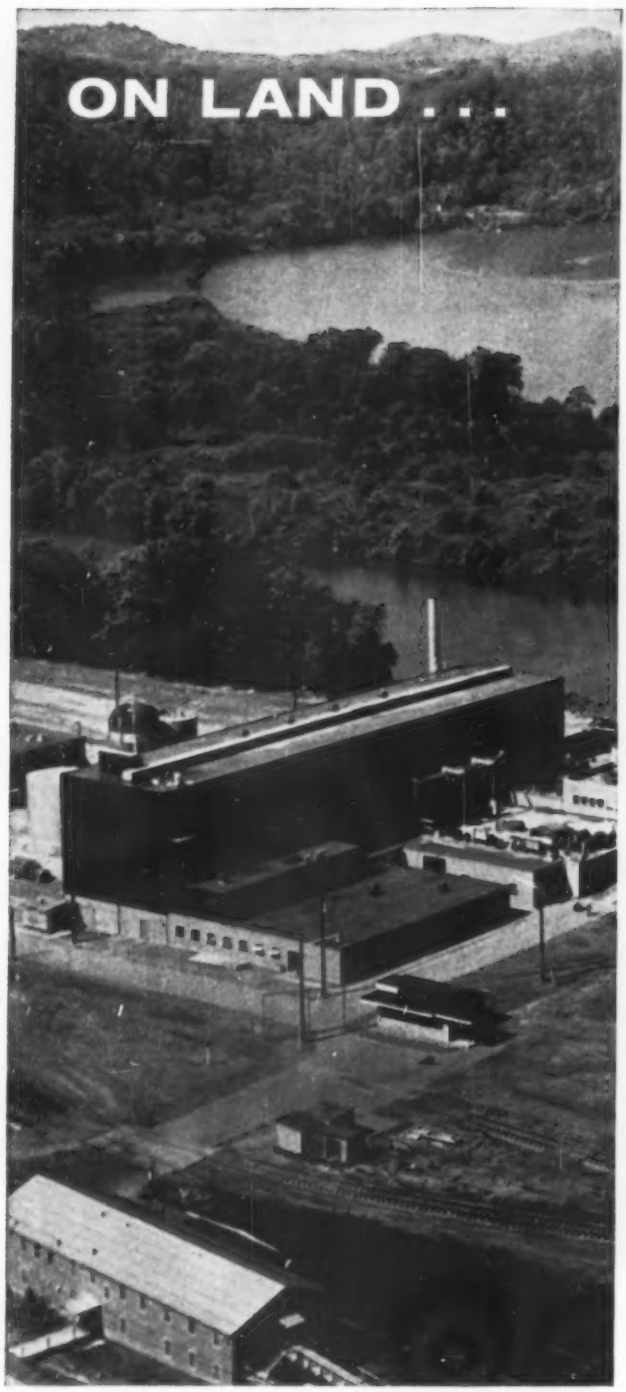

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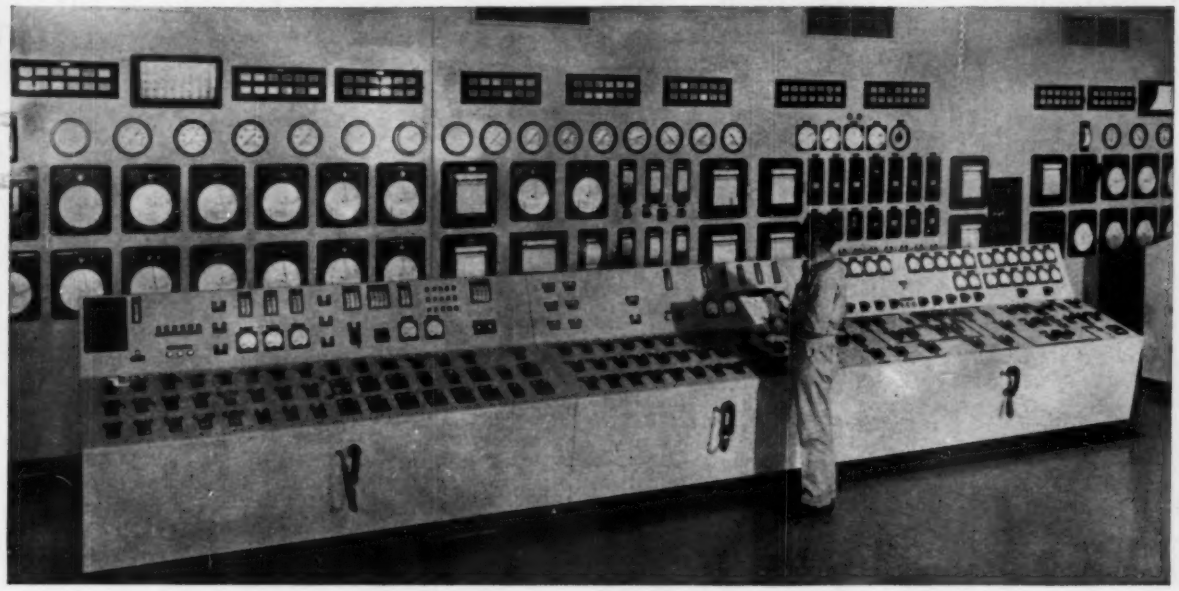

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Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to insure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

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In recent years the cost of new chimney construction and maintenance has skyrocketed due to greater use of more economical low cost coal, heavy fuel oil, refinery sludge and sour gases which form stronger acids resulting from the use of these high sulfur fuels. The lowering of the gas temperatures through the use of economizers has increased the problem. Heretofore no coating has succeeded in resisting these highly corrosive acid gases.

Now, after two years of intensive research and testing, Benjamin Foster Company releases STACKFAS—the world's first exclusive corrosion resistant material proved effective against high sulfur chimney gases.

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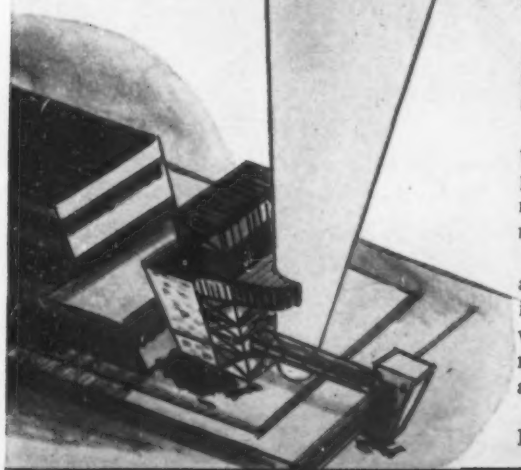
For complete details, specifications and applications of Foster STACKFAS, write for Bulletin No. SF-61.



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BPA NBP

THE AMERICAN POWER CONFERENCE

We recently saw another sign of optimism in the power field—the large attendance, and active interest, in the American Power Conference.

Despite the recent business recession and curtailment of travel expense, the large attendance at this meeting gave tangible proof that the power industry is on its way back to a normal pattern.

This year there was an excellent selection of papers, and most sessions enjoyed S. R. O. attendance. As always, the range of subjects ran from generation, through transmission and distribution, and into utilization.

Great interest was shown in power for peaking—both thermal and hydro—and in the unconventional power sources. This would certainly indicate that many power engineers are seeking solutions to present—or future—generation problems.

We, of POWER ENGINEERING, *were gratified to see that we had previously covered a large part of the conference subjects—with either specific or general editorials.*

One item of outstanding importance, not on the program, was TVA's announcement that their new 800-Mw units, for Clinch River, had been up-rated to 3500 psi—and 900 Megawatts.

Bob McCaw

EDITOR

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Engineers' Preview

OF NEWS AND COMING EVENTS IN THE POWER FIELD

INDIANA & MICHIGAN ELECTRIC CO will build a 580,000-kw, $73-million steam-electric generating unit at Tanners Creek Plant at Lawrenceburg, Ind. Construction will begin this summer and is expected to be completed by the spring of 1964.

The new unit is the fourth at Tanners Creek, and will be designed to operate at an anticipated heat rate of about 8500 Btu per kwh of net generation. The unit is expected to burn about 1,600,000 tons of coal annually, all of which will be delivered via river barge.

The new unit at Tanners Creek will raise that station's total generating capability to 1,105,000 kw. At that level and at that time, it will be the American Electric Power System's largest power plant and one of the major plants in the investor-owned utility industry.

Plans also call for construction of 186 circuit miles of 345,000-v transmission line and necessary substation facilities at an additional cost of over $12 million. These new lines will route the additional capacity from Tanners Creek into the I & M power system and, in turn, into the balance of the AEP System, as well as into the Indianapolis Power & Light system.

WESTINGHOUSE will completely equip a 37,500-kw power plant for the expanding Dalmine industrial complex near Buenos Aires, Argentina, which operates the only seamless steel tube mill in Latin America. The $3.5 million order was placed by Techint Engineering Co of Milan, Italy, which holds a substantial interest in Dalmine.

Also from Westinghouse are two 330,000-kw turbine-generator units for Pacific Gas and Electric Co's plant at Morro Bay, Calif. They are part of a project which will triple the electric generating capacity of that power plant.

ENGINEERS at Oregon State University have started laboratory tests on the sag or stretching that takes place in aluminum power lines. Findings will provide a valuable future guide to power line installation. Tests are being run for Bonneville Power Administration under a $13,300 grant. O. G. Paasche, professor of mechanical engineering, is project leader.

Stretching of the lines, technically known as creep, is sufficient at times to create a safety hazard, Paasche points out. In addition, adjustments to correct the condition and to keep the lines uniform are costly.

TVA has awarded a contract for 1,160,000 feet of condenser tubing to Wolverine Tube, Division of Calumet & Hecla, Inc, on its low bid of $313,276.96. The tubing will be used in the 500,000-kw generating unit now being built at the Colbert Steam plant in northwest Alabama.

The Wolverine bid was one of 12 received. It was lower than the bids of three foreign companies, and of all domestic bidders, including six companies that submitted identical bids.

CROSSETT PAPER MILL in Crossett, Arkansas, will get a big new power plant. Included in the installation will be a 20,000-kw steam turbine generator, a bark-and-gas-fired boiler with an hourly capacity of 300,000 lb of steam, systems for conveying waste fuel from other manufacturing divisions to the boiler and lines to return power and steam to them. Total capacity will be raised to about 1,000,000 lb of steam per hour and 36,000 kw of power.

Engineering and construction management services for this project will be provided by Rust Engineering Co.

MEETINGS: Fourth National ISA Power Instrumentation Symposium is set for May 8–10, La Salle Hotel, Chicago.

Hydraulics Conference sponsored by ASME and The Engineering Institute of Canada will be held May 8–11, Queen Elizabeth Hotel, Montreal.

ASME Spring Lubrication Symposium is scheduled for May 8–10, Deauville Hotel, Miami Beach, Fla.

National Telemetering Conference will be held May 22–24 at the Sheraton Chicago Hotel.

ASME's Design Engineering Conference and Show opens in Cobo Hall, Detroit, May 22, runs through the 25th.

ISA's International Instrument-Automation conference and exhibit opens June 5, at Toronto's Royal York Hotel and Queen Elizabeth Hall, runs through June 8.

Electrical Apparatus Service Assn. holds its annual convention at the Jack Tar Hotel, San Francisco, June 11–14.

AIEE's Summer General Meeting will be held at Cornell University, Ithaca, N. Y., June 18–23.

Massachusetts Institute of Technology will conduct its fifth special summer program in Scientific and Engineering Reports, June 19–23.

Second Joint Automatic Control Conference will be held June 28–30 at the University of Colorado, Boulder. Sponsors are AIChE, ASME, IRE and ISA. *(Cont'd on p. 6)*

ANACONDA Announces

A new high-strength copper-nickel-iron tube alloy that makes possible substantial economies in feedwater heaters

Research metallurgists of Anaconda American Brass Company have developed, after three years of intensive effort, a new high-strength copper-nickel-iron alloy — Cupro Nickel, 30%-707—for heat exchanger tubes in power plant feedwater heaters.

Alloy 707 has mechanical properties comparable with those of a premium high-strength alloy now commonly used, and retains its strength at elevated temperatures—allowing working stresses up to 15,200 psi at 600° F. Thus, in an important area of high-temperature heater application it provides material-cost advantages.

And as these high mechanical properties are for the metal in the *annealed* condition, Alloy 707 tubes can be readily cold worked—can be expanded into tube sheets and formed into tight U-bends.

MECHANICAL PROPERTIES of Cupro Nickel, 30%-707 (nominal composition, copper 64.15%, nickel 30.00%, iron 5.25%, manganese 0.60%) are as follows:

Tensile Strength, min, psi	74,000
Yield Strength, (0.5% Extension under Load), min, psi	36,000
Elongation, % in 2", min	30
Expansion of Tube Inside Diameter with Tapered Pin, %, min	30

STRENGTH AT ELEVATED TEMPERATURES. Extensive tests at room and elevated temperatures show that design stresses given below can be used for Alloy 707:

Maximum Metal Temperature, °F	Maximum Allowable Stress Values in Tension, psi
100	18,300
150	17,800
200	17,500
250	17,100
300	16,800
350	16,400
400	16,100
450	15,900
500	15,600
550	15,400
600	15,200

WELDABILITY. Alloy 707 can be welded by the same methods used for regular 30% cupro nickel.

CORROSION RESISTANCE. Alloy 707 has the same high resistance to stress-corrosion cracking and the same excellent resistance to corrosion by salt water as regular 30% cupro nickel.

FOR MORE DETAILED INFORMATION on this new high-strength tube alloy, Cupro Nickel, 30%-707, see your Anaconda representative, or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6169

ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Anaconda American Brass Company

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MONTANA POWER CO has filed with the Federal Power Commission an application for a 50-year license to build and operate power dams at Buffalo Rapids sites Nos. 2 and 4 and integrate their operation with that of the existing Kerr Plant on the Flathead River. The three-unit operation is called the company's Flathead Project.

Each Buffalo Rapids dam would have installed capacity of 120,000 kw, which, when added to the 168,-000-kw Kerr capacity, will give the three-dam project nameplate rating of 408,000 kw.

ONE HUNDRED TWENTY-NINE high school students and instructors will attend conservation workshops at the Trees for Tomorrow Camp in Eagle River this year on scholarships awarded by Wisconsin Public Service Corporation.

This is the 12th consecutive year that Public Service has provided conservation scholarships for high school students. Trees for Tomorrow was founded in 1944 to help build and maintain Wisconsin's natural resources, particularly its forests, and to provide conservation education. It is supported by 13 paper mills and five power companies.

BONNEVILLE POWER ADMINISTRATION's proposed facilities to be started in 1962 include two 230-kv lines to the Oregon coastal area to provide adequate service primarily to Bonneville's preference customers in the Tillamook and Reedsport areas. The 1962 requirements for these two lines are $654,-000, and total costs will be $8,240,000 when completed by the fall of 1964.

An amount of $380,000 is requested for 1962 for a 345-kv line and substation facilities between The Dalles area to the Portland area which will have a total cost of $13 million. The line is needed by the fall of 1964 to reinforce the system in the Portland and Willamette Valley of the Federal grid. Later this line will be extended to the John Day Dam when it comes on the line in 1967.

A 345-kv line between the Seattle area north to the Canadian border will be started to provide a means of transmitting a part of Canada's entitlement from cooperative development of the Columbia Basin. Total cost of the facility is $10 million and 1962 requirements are $425,000.

An amount of $1 million has been requested for construction of a 115-kv line from Lebanon, Ore., to the Green Peter Dam site. Total cost of this line is $1,165,000. It is scheduled for energization in the summer of 1962.

NAME of the National Industrial Service Association, Inc, an international trade association of electrical apparatus service companies, with headquarters in St. Louis, has been changed to Electrical Apparatus Service Association, Inc.

EASA, as the organization is now called, was founded in 1933 by 23 firms engaged in the repair and rewinding of electric motors, generators and transformers. There are more than 1600 member companies in five countries listed in the association's current roster, including members in every state and Canadian province.

FOUR 500-Mw single-line turbine generators are to be built for a new power plant in Britain which, at 2000 Mw, will have a higher over-all capacity than any station now in operation or under construction. All four sets are being ordered by Britain's Central Electricity Generating Board from the English Electric Co at a cost of more than $40 million.

The new plant will be sited at West Burton in the Trent Valley near the East Midland coalfield. The first generating unit will come into operation in 1965 and the plant should be fully commissioned by the end of 1967.

FEDERAL POWER COMMISSION has issued a 50-year license to the City of Seattle for its proposed Boundary hydroelectric project on the Pend Oreille River in Pend Oreille County. Seattle was authorized to build a thin arch concrete dam, about 385 feet high and 975 feet long, having two gated overflow spillways, gated spillway tunnel, four auxiliary fixed-wheel gated outlets, and four additional low-level outlets.

An underground powerhouse will have an initial installation of 540,-000 kw and an ultimate installation of 810,000 kw. Cost of the project is estimated at about $97 million. The 17-mile reservoir will have a total storage capacity of 94,000 acre-feet and a usable capacity of 42,000 acre-feet.

A. J. WATSON, president of Mississippi Power Co, has announced the largest construction budget in the company's history. Total construction expenditures during 1961 will be over $20 million. Largest single project will be continuing construction on the third generating unit at the Gulf Coast Plant, located between Gulfport and Biloxi. For this unit expenditures will be approximately $11½ million this year. This unit will be completed and placed in service next year, adding 112,000 kw of generating capacity and bringing the total generating capacity of this plant to 262,000 kw.

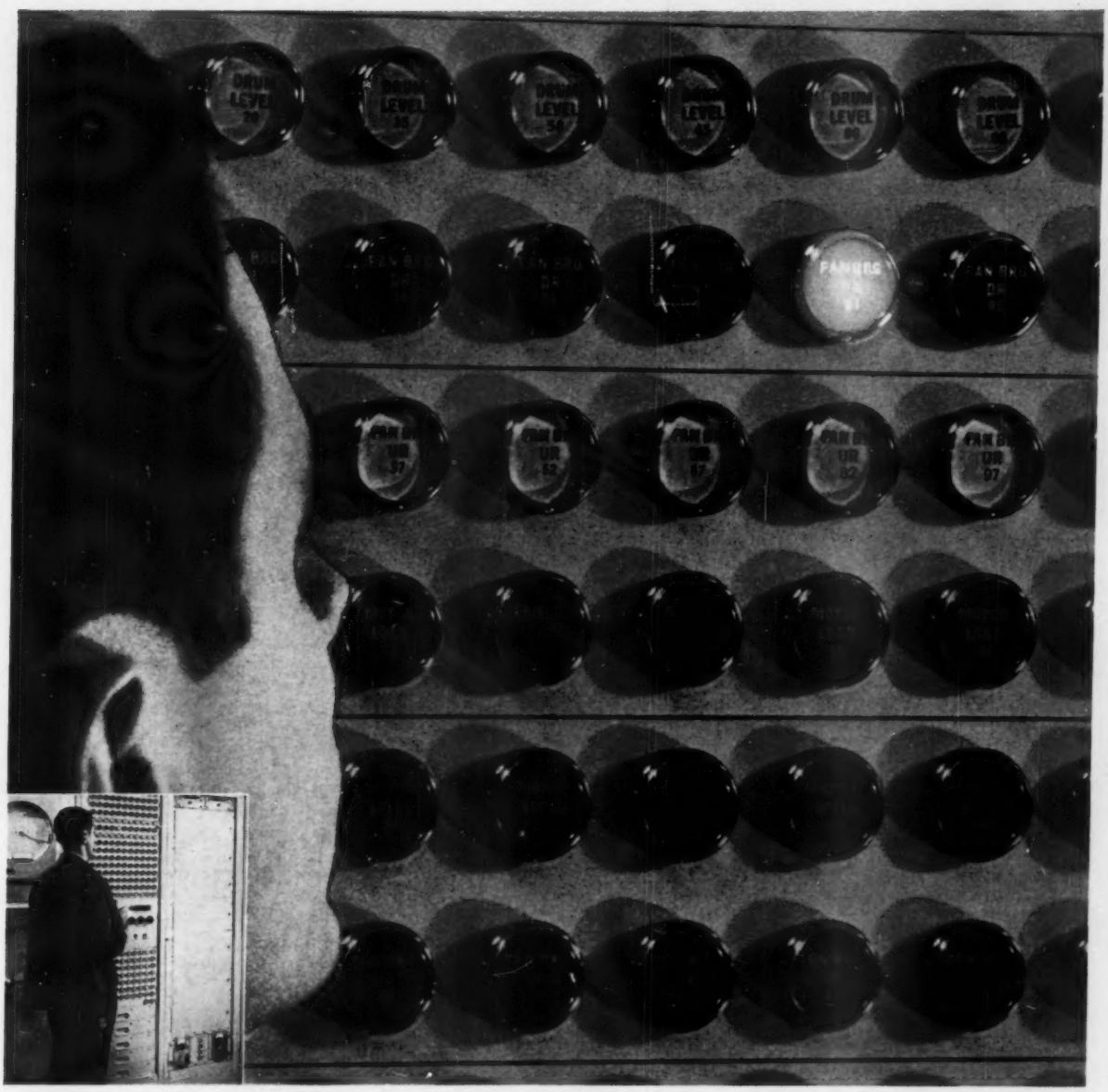
NEW 600-hp gas turbine is being developed by Solar Aircraft Co. Solar has received from the U.S. Navy Bureau of Ships a multi-million dollar contract for a joint Army-Navy development of a turbine which has very advanced design objectives.

Among the target characteristics for the engine are: life cycle equal to or better than conventional reciprocating engines — with considerably less maintenance; fuel consumption of 0.4 lb/hp-hr, equal to reciprocating engines and well below current industrial gas turbine performance; cost which is competitive with that of conventional reciprocating engines.

Solar's new 600-hp engine is a completely axial flow regenerative machine with a six-stage compressor, dual rotary regenerators, a single-can combustor, a single-stage gas producer turbine and a single-stage power turbine. The engine will operate at a compressor pressure ratio of 3.8 and have a rotative speed of 21,500 rpm.

FOUR San Francisco Bay Area open hearth steel mills are currently involved in a $250,000 gamble, which, if successful, will reduce their smog-producing stack emissions reportedly more than 99 per cent. Leading the way in this anti-smog experiment is Bethlehem Steel's South San Francisco plant.

Continued on page 86



DANGER! Out-of-limits

Just seconds ago a bearing temperature went out-of-limits . . . the Hagan AIM (Alarm Indicating Monitor) has energized the alarm light and sounded a warning horn . . . and, just seconds after the upset, the operator is ready to take corrective action.

Designed to protect valuable plant equipment, the Hagan AIM makes it possible for one man to monitor pressures, temperatures, flows, levels, closures from several critical areas at the same time. AIM can be set for either high or low alarm points, or both.

Combining all alarm functions in one instrument, the AIM will monitor *any* input which can be represented by DC voltages as low as 10 millivolts full scale, with an accuracy of ± 0.1% full scale. Providing maximum information on minimum panel space, the readout and alarm panel for 200 alarm points will fit into a 19″ × 47¼″ panel area.

For more information about the low-cost Hagan AIM, write or phone the address below.

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CHEMICALS & CONTROLS, INC.
HAGAN CENTER, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON CO. • HALL LABORATORIES • BRUNER CORP.

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Tracers

COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ Correction, please — and more information about TVA's big new 800-Mw turbine-generators! A typographical error crept into **George Palo's** article in the February issue, page 46, about the TVA order. It was there stated that "foreign bids would be charged an additional 40 per cent . . ." This figure should have been 20 per cent. Now George Palo, who is TVA's chief engineer, tells us:

> I wanted to advise you of our final decision between 2400-psi and 3500-psi units. We have decided to make this new unit supercritical at 3500 psi. In our evaluations we could not clearly establish the economy of the supercritical, but could determine that it was so close to the 2400-psi costs that any additional expense in this unit was well justified in the development of supercritical design, construction and operation.
>
> When these units were originally offered, they were referred to as 800-Mw capacity, although 865-Mw maximum output was guaranteed. On the units as finally awarded, a 900-Mw maximum output is guaranteed and that will probably become the rating used in our general discussions of these units.
>
> TVA has also announced that the first of these units will be installed at a site on the Clinch River a few miles west of Knoxville, Tenn., and initial operation of the unit is scheduled by the fall of 1965.

▶ Not long ago we stated that a 460-kv line is capable of carrying 16 times as much electricity as a similar line operating at 115 kv since capacity increases in direct proportion to the square of the voltage. This was challenged by **W. W. Wilson** of Inland Steel in this department in March. Now comes this comment from **E. H. Coxe** of Baton Rouge, La:

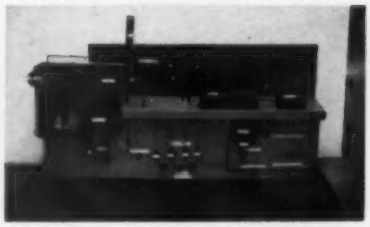
> I have read with interest the discussion of the increase in the power capacity of a transmission line due to increase of voltage from 115 to 460 kv on page 8 of your March issue; and I have decided that someone needs to go back to school.
>
> If the line copper (or aluminum) is not changed, it will still have the same current capacity. Since P = EI × 1.73 × P.F., and I, 1.73 and P.F. are presumably constant, power is obviously proportional to voltage. Now who should go back to school?

Getting into the fray, **Robert A. Parsons,** chief electrical engineer of Spang & Co, of Butler, Penna., sends this opinion:

> Referring to your March issue, I feel it is imperative to rise to the defense of Mr. W. W. Wilson whom you quote as taking exception to your statement of the relative capacities of 460-kv vs 115-kv transmission lines.
>
> To my way of thinking, the question is an elementary one which you have confused by inserting line loss factors.
>
> As you state, if the amount of power, line distance and line loss remain fixed, the 460-kv line could have a cross-sectional area 1/16 that of the 115-kv.
>
> The contested statement, however, was that a 460-kv line is capable of carrying 16 times the electricity as a similar 115-kv line. I construe the word "similar" to mean a line of equal length, equal copper, and equal current flow to retain equal line loss. In this case, the only factor in question is the amount of power which can be transmitted.
>
> Under the above conditions (ignoring the load power factor which we can assume constant), the formula to apply would be P = IE 1.732 pf. Obviously, the only variables are the voltage and power which vary directly.

Any more takers? We still stick to our rebuttal, published in this department in March.

▶ Reprinted first in 1954, POWER ENGINEERING's Power Plant Primer, by **Andrew W. Kramer,** continues to win friends and influence people. Not long ago, 12-year-old **Mike Davis,**



who attends the GESU School in Toledo, Ohio, read the Primer and decided to use it as the basis for a 7th grade science project. Following Primer descriptions, Mike built the model of a power plant, shown in the photograph above.

An added note of interest to this story is that Mike is the son of **Bill Davis,** POWER ENGINEERING's sales representative for the East North Central district.

▶ **Bill Corbitt,** assistant to the director of public relations for the American Electric Power Service Corp, writes:

> Many thanks to you for the copy of POWER ENGINEERING featuring the life and times of the Breed Plant (March issue, page 55). I thought your pictorial display, put together in a few pages, much more impressive than when it was done in that extended display at the dedication.

▶ **Harold P. King** of Sherman Oaks, Cal., will be installed president of the Consulting Engineers Council at the fifth annual board of directors meeting, May 4-6, in Chicago.

Alf Kolflat, senior partner of Sargent & Lundy, has retired from the firm. **Frank V. Smith,** general manager, has been named as his successor. Kolflat joined the company in 1925.

Garland S. Landrith, Jr, of the staff of Edison Electric Institute, has been appointed general manager of the electric utilities' exhibit for the N. Y. 1964-65 World's Fair.

Maintenance and Steam Traps

. . . there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

Proper Selection of Steam Traps

1. Be sure it's the right type of trap.
2. Be sure it's sized right and is for the correct operating pressure.
3. Be sure it's first rate in design and construction.

Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.
2. Install a test valve.
3. Use a union or unions.
4. Use a shutoff valve or valves.
5. Use a strainer ahead of the trap if dirt conditions are bad.
6. Use a by-pass only where continuity of service is imperative.
7. Standardize inlet and outlet connections.

Preventive Maintenance Program

1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)
2. Inspect internal mechanism at least once a year.

You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance . . . testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and burning equipment and on ash handling equipment.

Good traps protect the system by eliminating water hammer and preventing the damage it can do.

Good traps discharge carbon dioxide before it can go into solution to form corrosive carbonic acid —less corrosion, less maintenance.

Good traps increase production to reduce the length of time equipment must operate or reduce the amount of equipment needed . . . either way maintenance is reduced.

How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

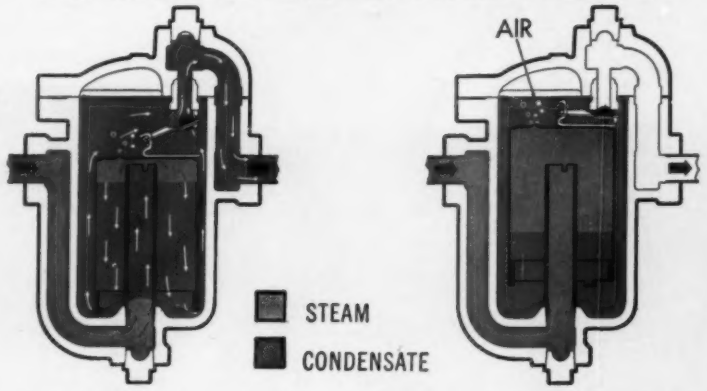
1. Armstrong Traps are dependable.
2. Armstrong Traps require no adjustments — go from full load to zero load automatically.
3. Armstrong Traps are self-scrubbing—ordinary dirt conditions can't hurt them.
4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.
5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book—there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, or write

Armstrong Machine Works
8102 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

HERE'S THE STEAM TRAP DESIGN THAT CAN REDUCE YOUR MAINTENANCE PROBLEMS

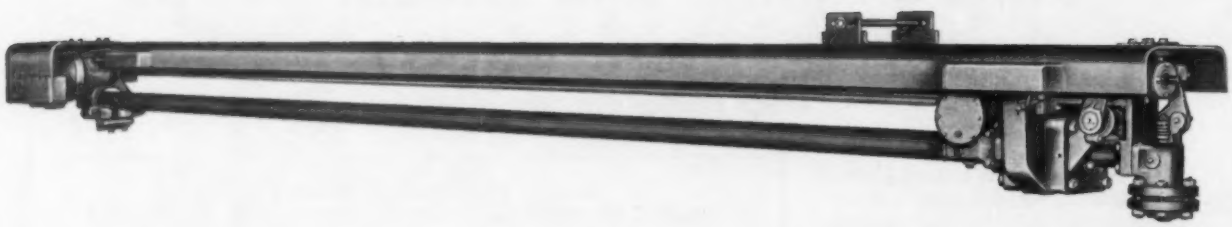


Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

See our catalog in Sweet's Plant Engineering File

For more data circle 505 on Post Card



Diamond developed for more economical power...

CHEMICAL CONTROL

Lower fuel costs . . . reduced boiler outage . . . minimum manual cleaning . . . inhibited tube corrosion—these are dramatic savings achieved by Diamond Chemical Slurry Spraying Systems, a revolutionary method of controlling and removing tube deposits generated by burning oils high in vanadium, sodium and sulphur content.

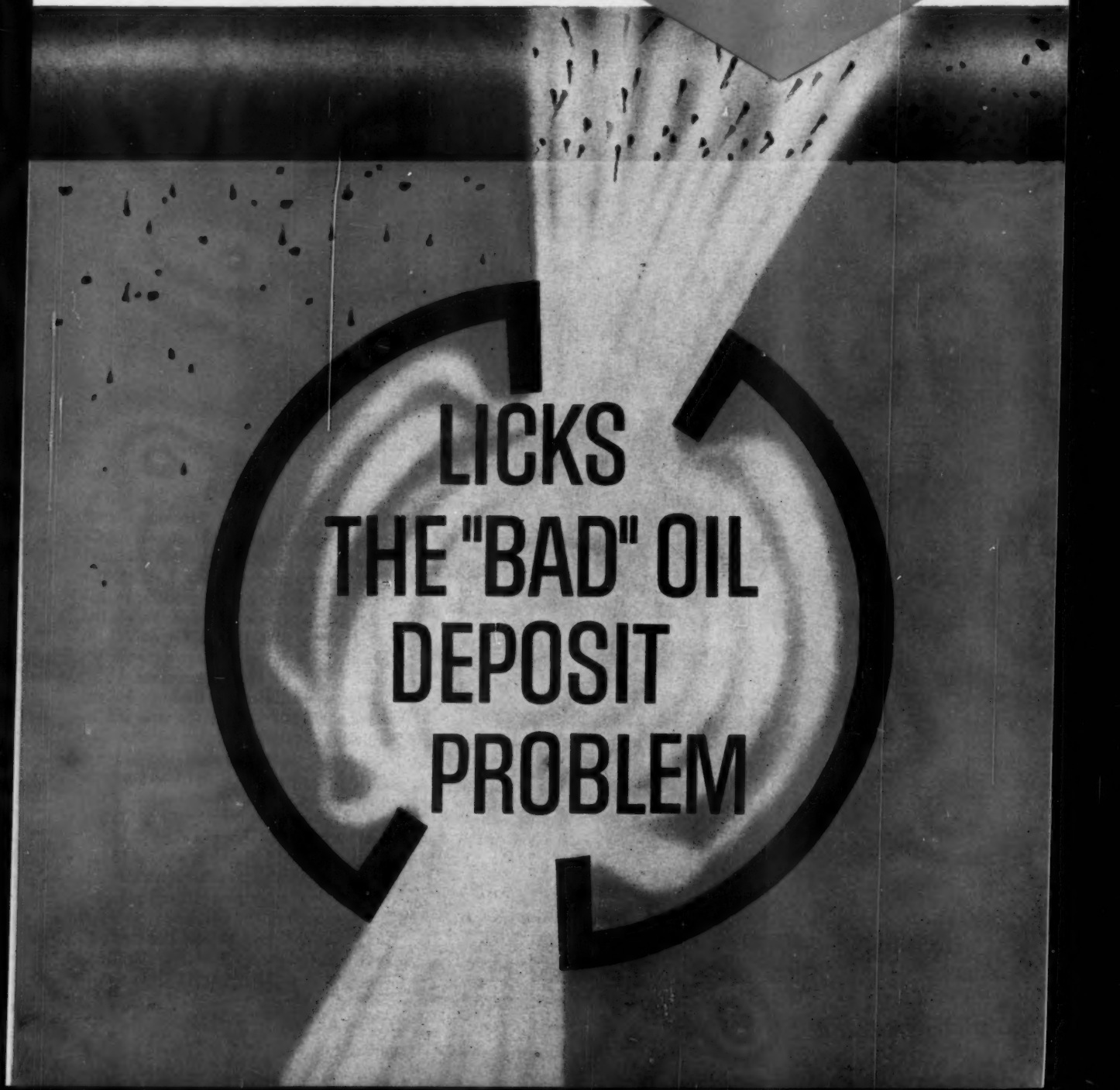
Service tested on some 40 installations, Diamond Slurry Spraying offers a distinct economic advantage over fuel additives because it treats only that ash which collects on the tubes. Magnesium oxide-based slurry is sprayed on heating surfaces by conventional soot blowers modified to discharge, in alternate cycles, both the normal cleaning medium and slurry. The chemical slurry coating changes chemical composition of deposit so that it's easily removed by normal blowing.

If you burn — or are considering burning low-grade oil, it will pay you to take a close look at Chemical Slurry Spraying . . . another Diamond-Developed Boiler Cleaning System. At your request, our engineers will make recommendations based on your specific requirements. Call, write or wire for complete information.

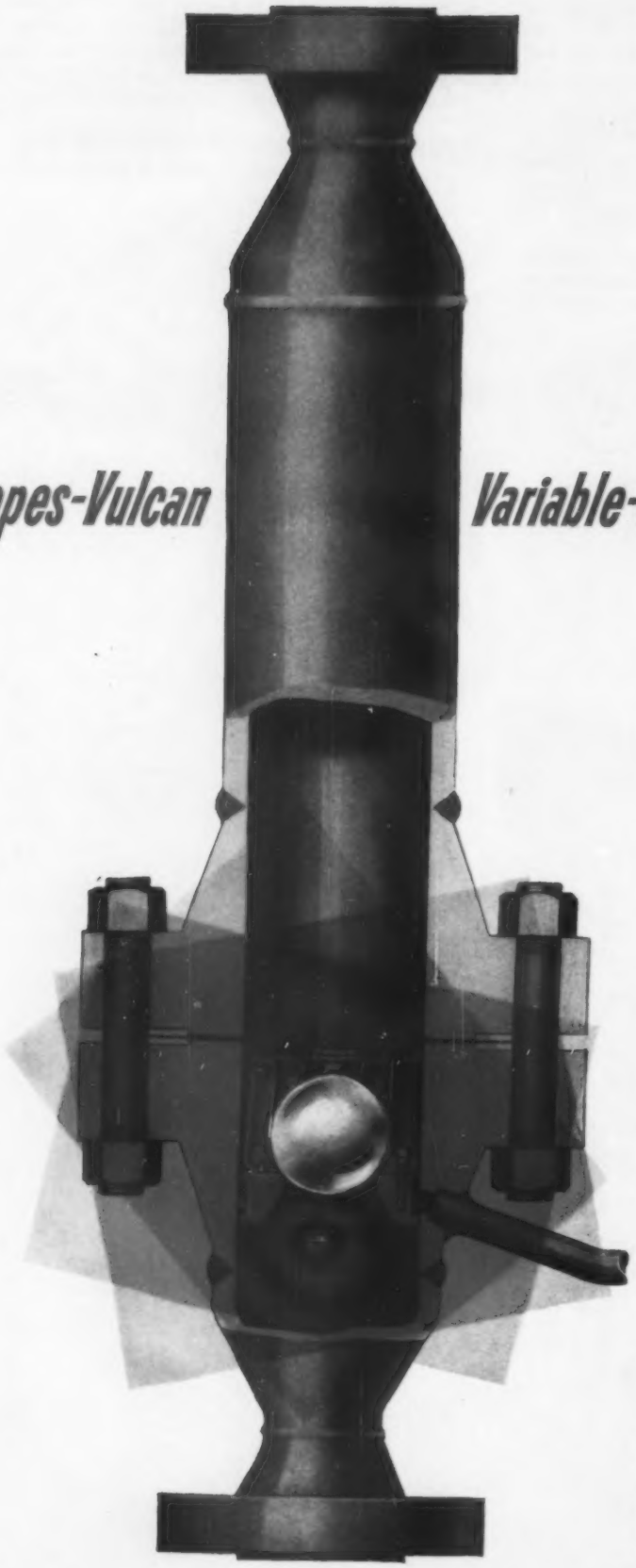
DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

DIAMOND SPECIALTY LIMITED, Windsor, Ontario

Diamond



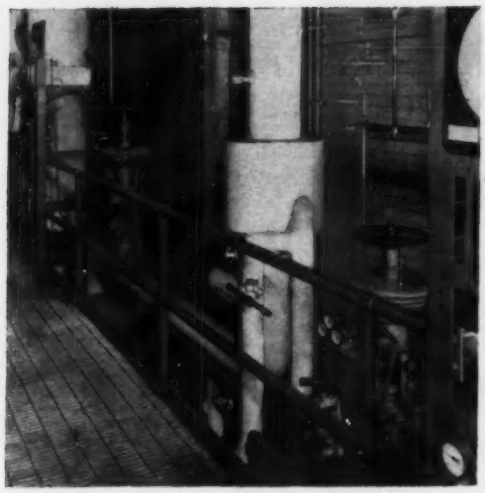
Copes-Vulcan Variable-Orifice desuperheater



This ball makes the difference. Steam pressure lifts a weighted steel ball off its ring seat to a position where it is balanced by steam pressure and flow through the orifice. The ball is held concentric by Inconel springs and rigid guides. This is the only moving part in the Copes-Vulcan Variable-Orifice desuperheater that so effectively controls steam temperature.

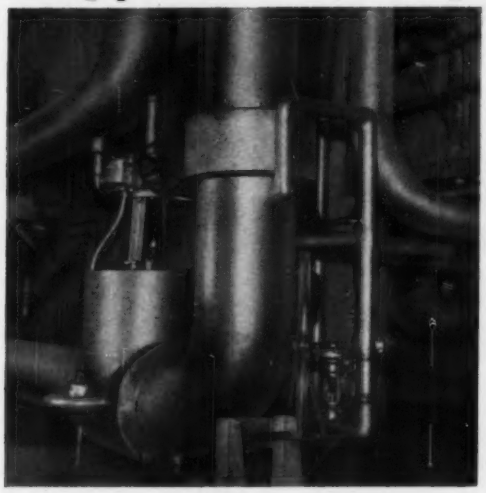
Cooling water enters through an annular orifice surrounding the ring seat at the point of maximum steam velocity. The passage of steam through the annular restriction between ball and seat produces an aspirating effect on the cooling water and entrains it in an area of high turbulence over the full range of flow.

No long run of piping is needed to mix the two fluids. There is no excess water to remove. No atomizing steam is used. There are no glands, stuffing boxes or spray nozzles. Pressure drop remains constant for all flows, and is normally 3 to 4 psig. Write for Bulletin 1037.



The problem: to maintain the temperature of residual fuel oil at 335°-380°F using station steam at 1250 psig and 950°F. Because of the high temperature heating requirements of the fuel, it was necessary to use the station steam supply. To handle this tough assignment a single, combination pressure-reducing and regulating valve, Copes-Vulcan Type CV-D, followed by the Copes-Vulcan Variable-Orifice desuperheater was used. The cooling-water valve is also a Type CV-D. The desuperheater provides steam at the right temperature to control the fuel oil temperature and viscosity exactly. It has been in service over two years with no downtime and no operating problems.

solves knotty problems at two generating plants



The problem: to deliver 420°F steam at from 20,000 to 300,000 pounds per hour and within ± 5°F of the set point. Conventional desuperheating equipment could not be used because of the low superheat (30°F) and low flow conditions. A 12-inch, 300-psig standard Copes-Vulcan Variable-Orifice desuperheater, with outlet expanded to 20-inch pipe size, was the answer. The inlet is connected with the main steam-distribution header carrying steam at 220 psig and 500°F. The cooling-water supply is at 450 psig and 200°F. The specified pressure range is 425 to 475 psig. Cooling-water flow is automatically regulated by a Copes-Vulcan Type CV-D valve operated by a temperature controller in the steam heating supply line. Flow requirements at discharge temperature within ± 5°F have been met consistently though inlet temperatures vary from 520°F to 550°F.

Copes-Vulcan desuperheaters are designed for precise control of reduced steam temperatures under the most difficult operating conditions.

In addition to the Variable-Orifice, two other types are available. *The Carburetor-Type desuperheater* injects cooling water into the system with a spray nozzle. Available in standard 2-inch through 12-inch sizes in 150- through 600-pound pressure standard for cast steel. Larger sizes and higher pressure standards are available on special application. Write for Bulletin 1056.

Steam-Assist desuperheater has negligible permanent pressure loss on loads of 15% to 100% of maximum. This in-line desuperheater normally uses assisting steam only on light loads where control is most difficult. Write for Bulletin 1024-A. Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division

BLAW-KNOX

BLAW-KNOX

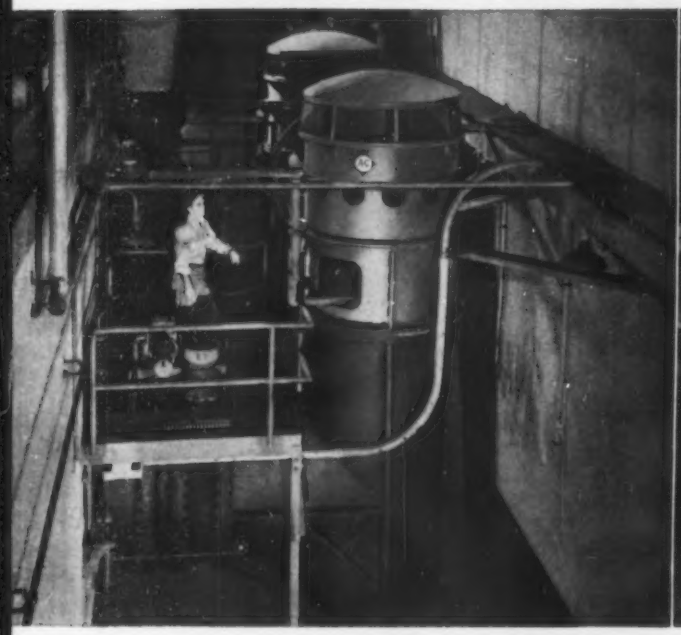
Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms • Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes • Towers and Special Structures • POWER: Power Plant Specialties and Valves

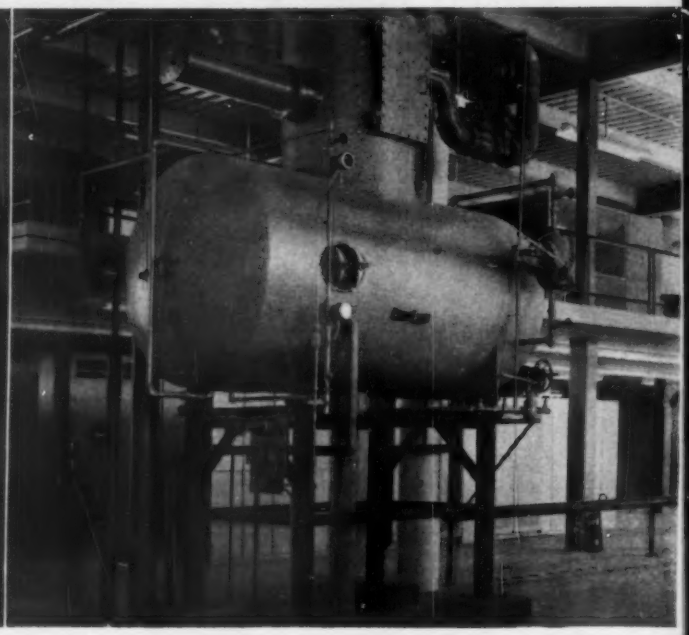
For more data circle 507 on Post Card

Current news reports

WHAT'S HAPPENING IN POWER SERVICES?

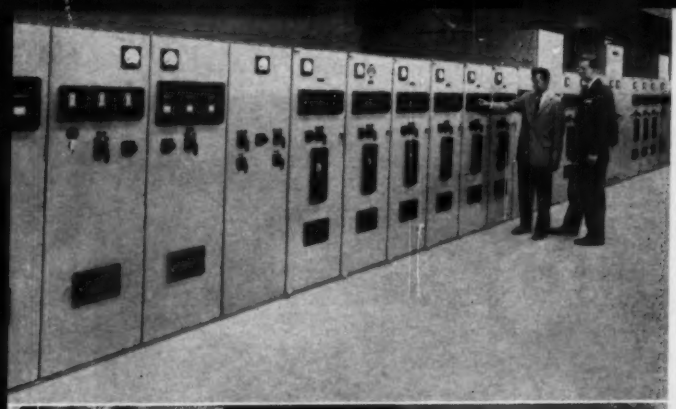
Highlights: Switchgear with the lowest silhouette on the market. A "guided flow" condenser that slashes space requirements. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity that are yours when you buy A-C products, systems and services. Call your nearby Allis-Chalmers office for details or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.



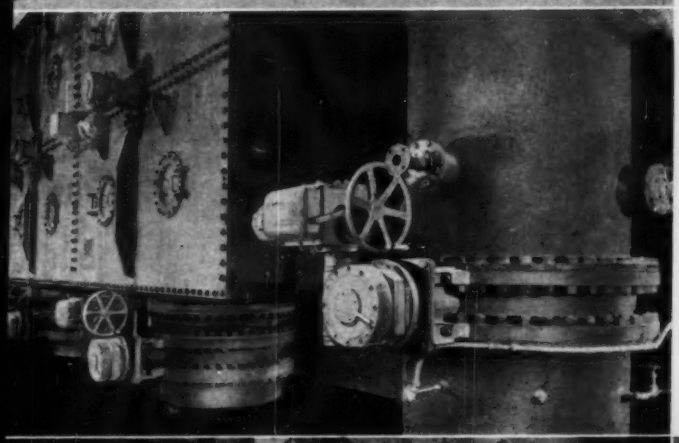


Rugged construction for continuous operation at highest possible efficiencies — yours with these condenser circulating water pumps and vertical induction motors. All pumps are tested at rated head and capacity to assure guaranteed performance. Available in a wide variety of materials to meet your installation needs. *Super-Seal* motors, with *Silco-Flex* insulation, assure complete reliability for outdoor installations and areas with high humidity or contaminated atmospheres.

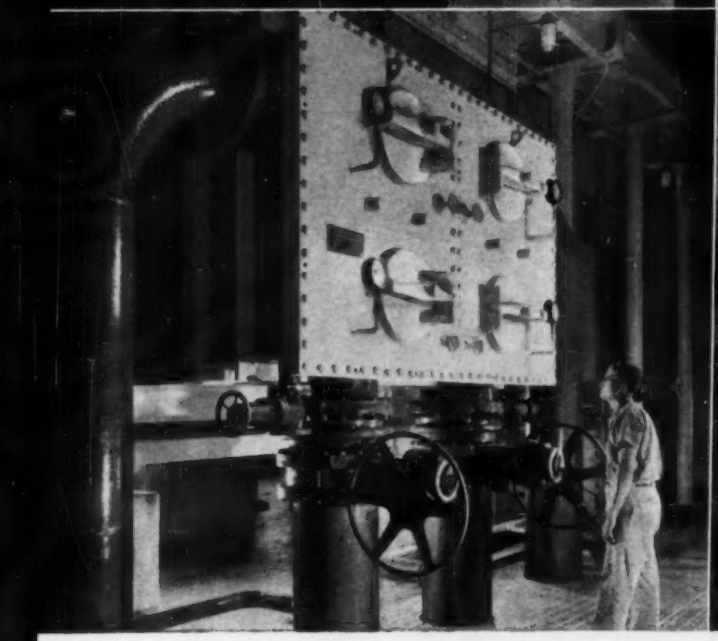
Stainless steel "scorns" corrosion — It's standard with all Allis-Chalmers tray-type deaerator internals. This 90,000 lbs. per hour "package" unit removes oxygen and other corrosive gases besides heating boiler feedwater. Heating and distributing tray design provides greater spillage edge — extra-efficient air separating trays remove more oxygen and gases through full counterflow design. Protects boiler and associated steam and condensate equipment from corrosive attack.

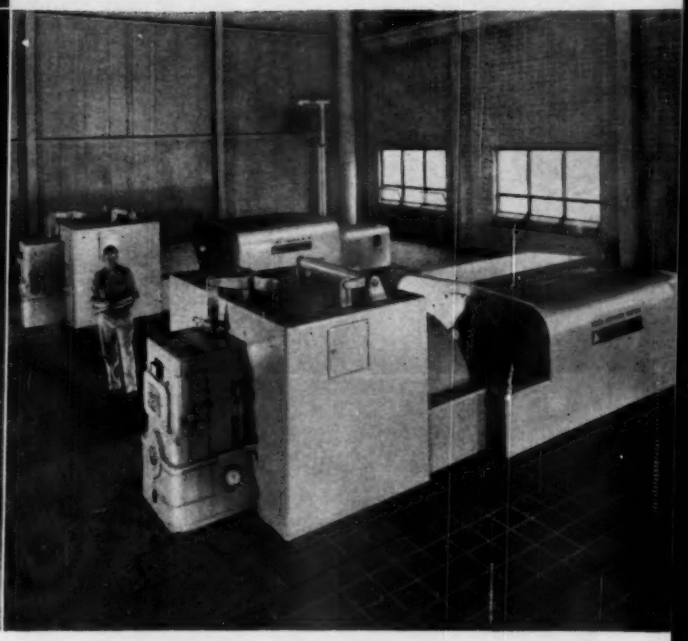


Lowest height, easiest access 5-kv metal-clad switchgear on the market. Just 72 inches high, you get eye-level instrumentation, shoulder-height accessibility of component parts. Other outstanding advantages: front-accessible current transformers; maximum compartmentation and dead-front construction for greater safety; full-panel metering; rapid, one-stroke breaker insertion. Choice of stored energy or solenoid operated circuit breakers.



Eliminate tuberculation and oxidation, reduce maintenance with rubber-seated butterfly valves. Operation is always extra-smooth and easy with 100% effective shutoff. Full body protection is offered by a rubber seat that extends through the valve body and over the flange faces. Angle seating protects the rubber seat and permits seating adjustment without costly disassembly. Being light and compact, these valves require less space and support than most other types.





Extra-compact rectangular steam condenser shape reduces space requirements. "Guided-flow" design achieves highest efficiency and vacuum with available water temperatures . . . gets maximum temperature condensate at the hotwell. Internal reverse-flow design for cooling water effectively backwashes debris, ends costly shutdown, conserves space, requires no additional piping. Planned-as-a-package auxiliary condenser equipment also available.

Two non-condensing, automatic extraction steam turbine-generator units (3000 kw) — for a hospital center where extraction and exhaust steam are used for heating and other services. You get the advantages of two steam pressures — high pressure by automatic extraction and low pressure from the exhaust. Use of pressure-reducing valves and desuperheaters is minimized where a wide range of process pressures is desired.

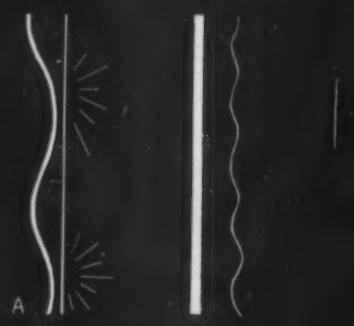
Super-Seal and Silco-Flex are Allis-Chalmers trademarks.

ALLIS-CHALMERS A-1479

For more data circle 508 on Post Card

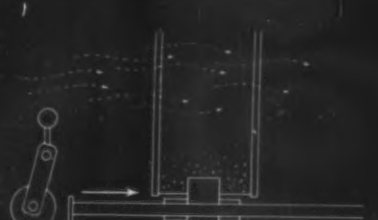
COLLECTING ELECTRODE DESIGN ANOTHER REASON FOR SUPERIOR PERFORMANCE OF BUELL PRECIPITATORS

HEAVIEST CONSTRUCTION, ONE-PIECE FABRICATION Rolled, from a single piece, the structural design and thickness of the Buell collecting electrode provides the strength to retain proper shape and alignment in erection and operation.



EASE OF HANDLING AND INSTALLATION – Rugged sections can be installed without bending or distortion thereby eliminating the possibility of 'arc-overs' (A).

OPTIMUM FLEXIBILITY IN DESIGN OF PRECIPITATOR –Standard 16" width (B) allows increase in size of precipitator by smaller increments (not by 3 foot (A) or longer sections). Permits economical sizing of precipitator to specific requirements of efficiency and space.



POSITIVE "SHEARING ACTION" DESIGN – No reentrainment of dust in rapping. Each row of electrodes is rapped separately–in the direction of the gas flow–on a continuous cycle. Dust is sheared off, drops in an agglomerated mass, and pockets on electrodes minimize reentrainment.

Add to this Buell's exclusive baffling system adjustable after installation for uniform distribution of gas flow, sealed insulators, rigid, 4-point suspension of emitting system, and high emittance, minimum maintenance Spiralectrodes and you have a combination that's hard to beat. You'll be glad you decided on Buell precipitators when you experience superior performance and minimum maintenance. Buell Engineering Company, Inc., Dept. 52-E, 123 William Street, New York 38, New York. Northern Blower Division, 6434 Barberton Avenue, Cleveland, Ohio. Electric Precipitators • Cyclones • Bag Collectors • Combination Systems • Fans • Classifiers

buell Norblo

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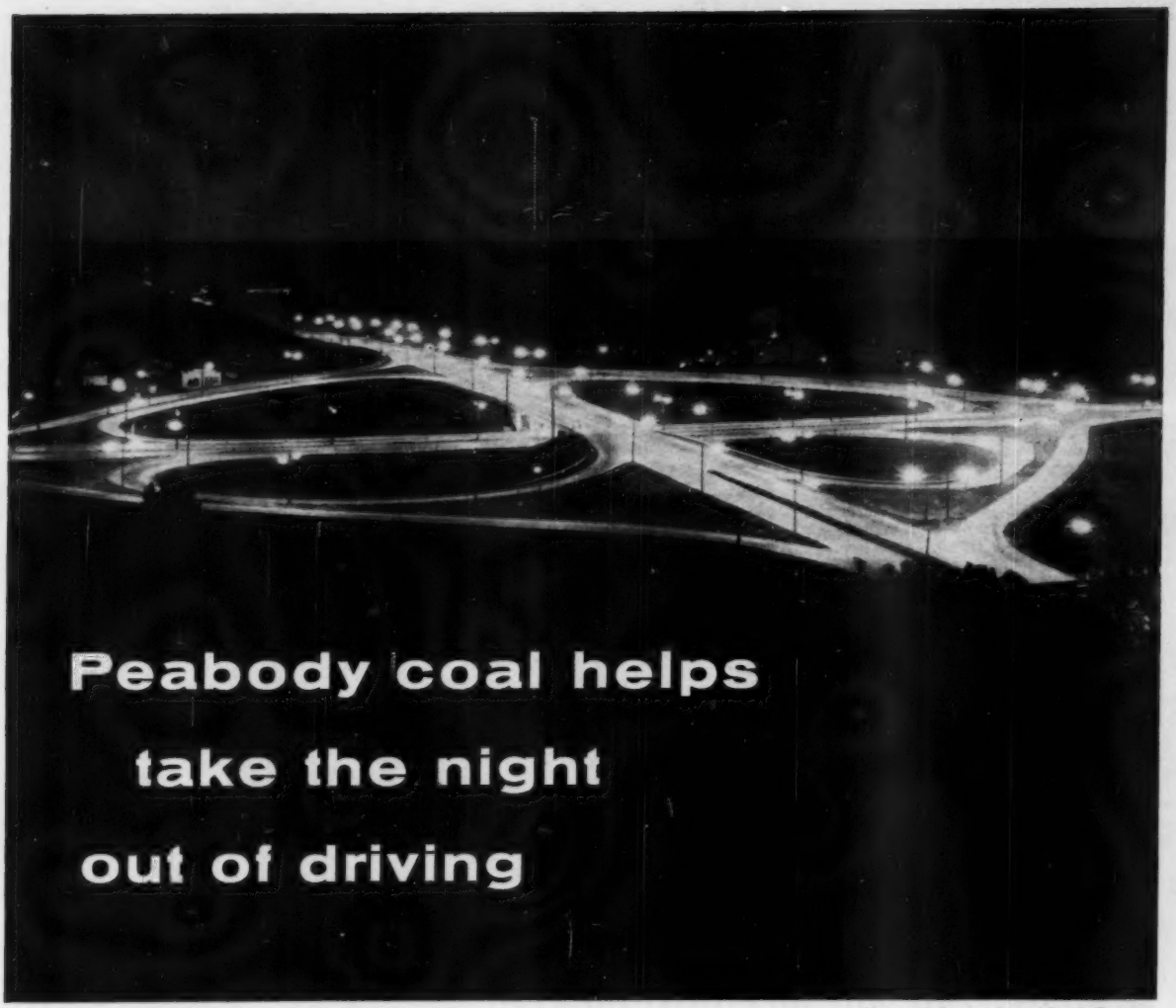

Photograph Courtesy General Electric Company

Economical, Coal-Generated Electricity Saves Thousands of Lives by Making Night Driving Safer for You

One of the greatest safety devices developed in recent years is the *lighted highway*. When you whiz along a bright expressway, you probably don't realize that your driving safety has been increased by coal. Stabilization of coal prices has helped our great Electric Utilities provide you with *more* and *better* services at low cost.

On the highways, in your home, office and plant, day and night, coal serves you by generating dependable, economical electricity. Peabody Coal Company, with over two billion tons of proven reserves, supplies many of the nation's leading Electric Utilities that bring you this efficient power . . . at a price you can afford to pay.

If you are seeking a new plant site, Peabody can be of assistance to you. Contact us for information on strategic industrial locations. No obligation, of course! Call today or write Department PE.

power for progress

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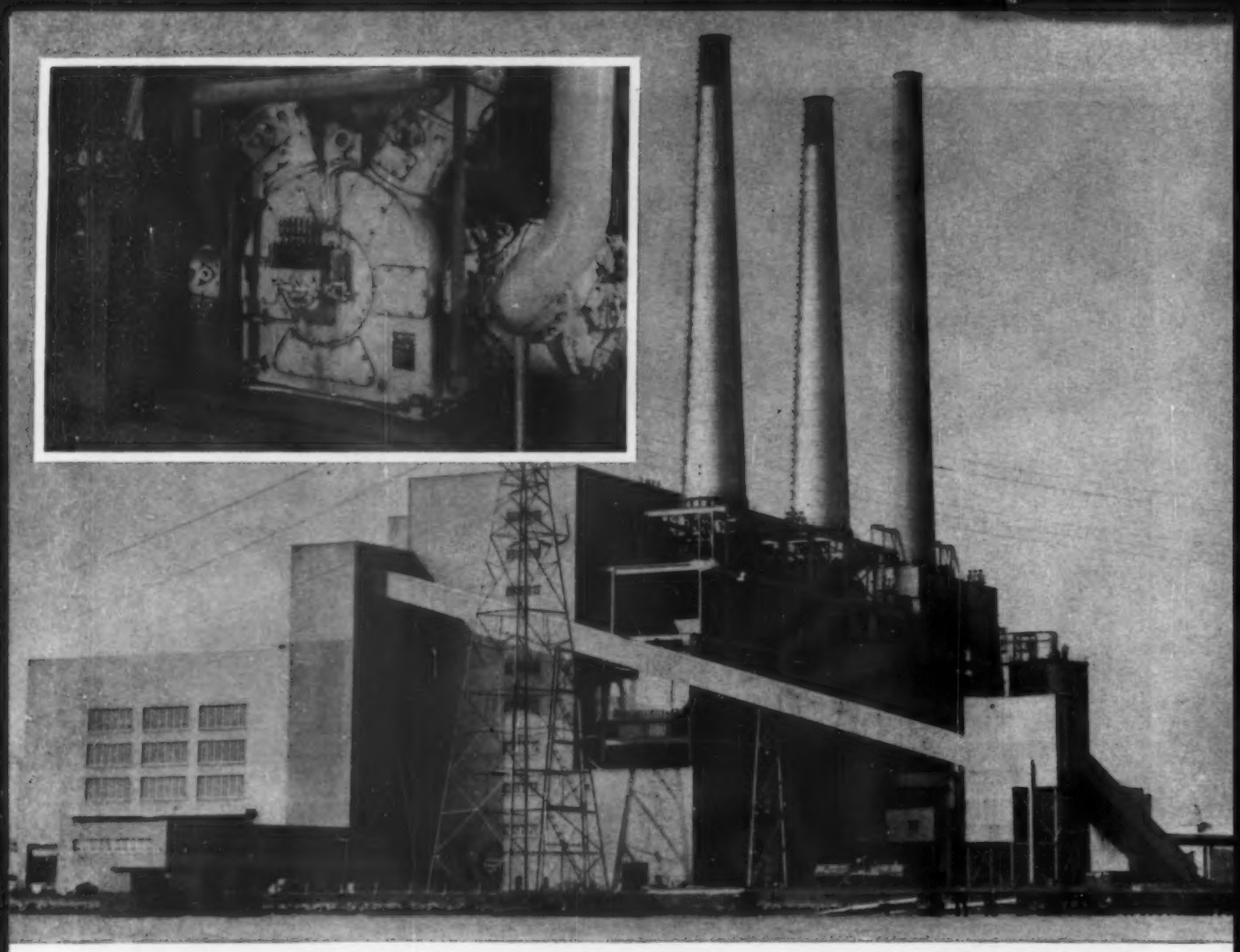


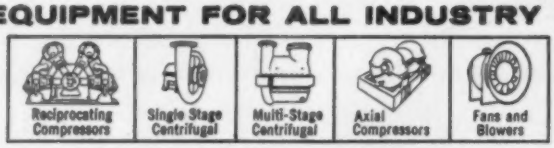
MODERN JOY WH-234 COMPRESSOR SUPPLIES 300 LB. SOOT BLOWING AIR AT DETROIT EDISON'S RIVER ROUGE PLANT

A Joy WH-234 Semi-radial Compressor was installed at the River Rouge Plant to provide additional 300 pound soot blowing air when a huge 321,500 KW turbine-generator was added in 1957. The new unit gave the River Rouge Plant a total installed capacity of 841,500 KW, making it one of the largest power plants in the country.

Joy's modern semi-radial construction provides a compressor which is both rugged and compact. Floor space requirements are less than for any other type of compressor of comparable capacity, yet valves are easily accessible for inspection and maintenance. Truncated piston design gives high compressor efficiency by reducing head clearance to a minimum—cutting re-expansion loss. Like all Joy compressors, the WH-234 features replaceable cylinder liners and crosshead guides, force-feed lubrication and rugged construction throughout for long, maintenance-free service life.

Consult your Joy representative for complete details on Joy high pressure compressors for soot blowing, or write for Bulletin 2554-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

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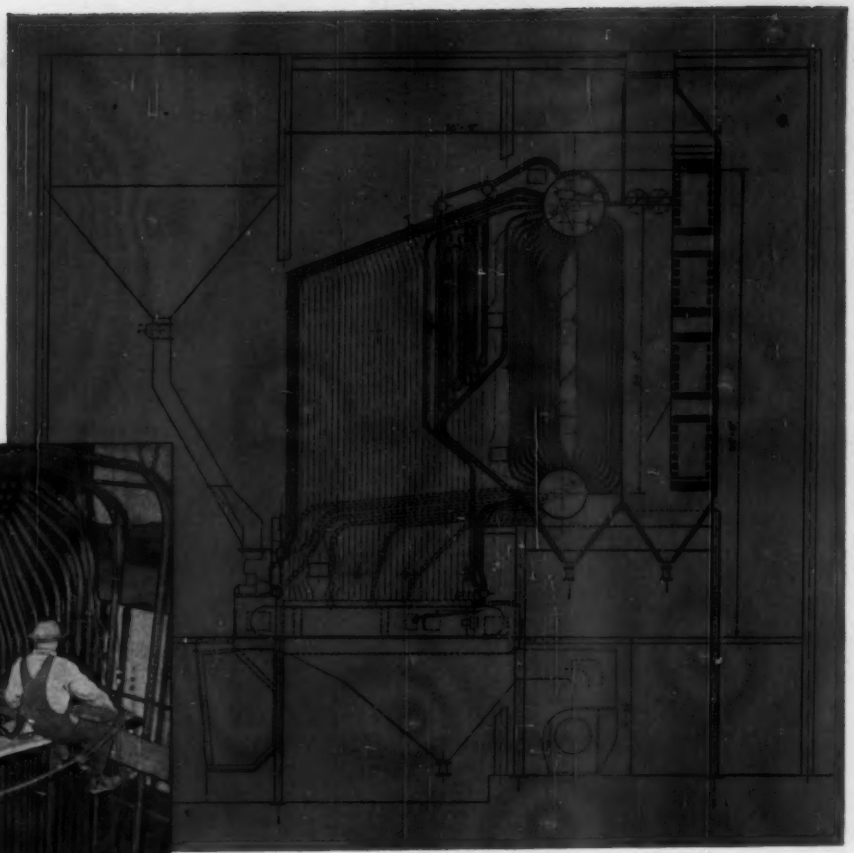
Union Starch Installs a Modern Coal Fired Steam Generator



Longitudinal section through unit.

Tubes being installed in steam and water drums.

PROJECT BY
ROGERS SCHMIDT
ENGINEERING CO.
ST. LOUIS, MO.

This 125,000 pounds per hour capacity Vogt Steam Generator, especially designed to burn bituminous coal, serves the Granite City, Illinois plant of the Union Starch and Refining Company. The unit operates at 475 lbs. pressure and delivers steam at 750°F. total temperature. It has water cooled front, sides and roof of furnace and employs a spreader type coal stoker.

Vogt offers a complete line of custom built and package type steam generators for power, processing and heating. Bulletins are available upon request.

Vogt

For Custom Installation Bulletin VF-VS-2 • Package Unit Bulletin PSG-3, address Dept. 24A-BPE.

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STEAM GENERATORS

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ONE OF A SERIES OF CHATS ABOUT CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

MODERNIZING A STEAM SYSTEM MEANS TRAPPING, TOO

Take an older building that has generated its own steam for decades and let's say it's switching to district steam. How can it take advantage of switch-over to rid itself of those classic symptoms of antiquated systems: trap maintenance at overtime rates, water-hammer, and live steam loss?

Well it just so happens a 17-story office building at 635 Madison Avenue, New York, recently did just that. Its steam system was overhauled; but recovery is now complete and it didn't hurt a bit.

First, let's look at the system as it was: Maintenance of the old system had to be done at overtime rates in off hours, because the system could not be shut down during business hours. There were frequent breakdowns. Passage of live steam into return lines when traps failed open not only wasted energy but caused water hammer, and when traps failed closed, water accumulated in steam supply mains and equipment.

The reason we give you this dreary picture is that it's so typical of old systems, and so easily fixed. The building management simply replaced bucket and float traps with Sarco Thermo-Dynamic Steam Traps, Type TD-50, matched and correctly sized to the application. And at the risk of sounding like a TV commercial, results were immediate: maintenance practically

zero, no water hammer, no loss of live steam, engine room crew free for other jobs. And, need we add, considerable savings.

We find it difficult to be modest about the TD-50 because it comes so close to being a cure-all. The facts are these: It has only one moving part, a stainless steel disc; it shuts off *positively*, so no steam can be lost; it discharges condensate as rapidly as it is formed; its pressure range of 10-600 psi makes it possible to standardize on one steam trap for a variety of applications that formerly required traps of many types and ratings.

Funny thing is, the TD-50 is so dog-gone *simple* and *small*, people find it hard to believe it does what it does. At 635 Madison Avenue, for example, changeover took only 30 minutes per trap, and trapping was accomplished with a few pounds and cubic inches of traps where hundreds of bulky pounds were needed before to do the job.

Write us for details, won't you? You've nothing to lose but your troubles, your waterhammer, and your worries.

HEATING COILS CAN CATCH COLD

Let's face it: even the best "non-freeze" air heating coils may freeze if they handle incoming air even slightly under 32°F. and aren't drained properly. Let's face it again: It's *not* inadequate steam trapping capacity that's most usually to blame. We don't mean to belabor the point, but if trap inlet pressure falls lower than trap outlet pressure, condensate *is* going to collect in the coil. And it's *bound* to freeze below 32°F. Take a preheat coil designed to heat air from 0°F. to 50°F. using steam at a maximum pressure of 10 psig. As the outside air temperature rises above 0°F. heat demand decreases the temperature controller reduces the steam pressure to compensate for reduced heat demand, and you're ripe for ice cubes in your coil tubes.

At Sarco we firmly believe that practical help is much more useful than sympathy noises. We can tell you (if it happens to be *you* who are caught with your temperature down) of at least three cures for fatal drop in pressure differential. They're quite simple and we would show not the slightest hesitation about revealing them to you.

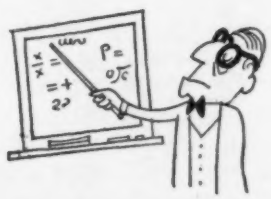
In fact, we'd also like to send you a master chart that enables you to check at a glance the danger point in handling outside air—an extremely useful piece of information—and a bulletin on Float-thermostatic steam traps.

It may hasten matters if, when you request this bundle of facts, you refer to the literature as Sarco Technical Bulletin No. T503.

MORE THAN ONE WAY TO TRAP STEAM

Just as there's no universal trapping application, there's no universal steam trap. The fact is that there are five basic steam traps in use today—and they're all rather thoroughly described in a rare monograph by Sarco engineers titled modestly and succinctly enough: Lecture 1A. You, personally, may not need a copy of this fundamental document, but wouldn't you like to know that your own people were up to date on steam trap basics?

It's easy to be sure this vital information gets into their hands: simply request a quantity of Lecture 1A and distribute copies as needed, with a little subtle persuasion that they be read. We can even arrange for a personal slide film lecture, followed by authoritative answers to trapping questions, if you can get an in-plant group together.



In any event, write to us. You may discover that a lot of progress is being made that isn't concerned with getting men to the moon.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate. 5108

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

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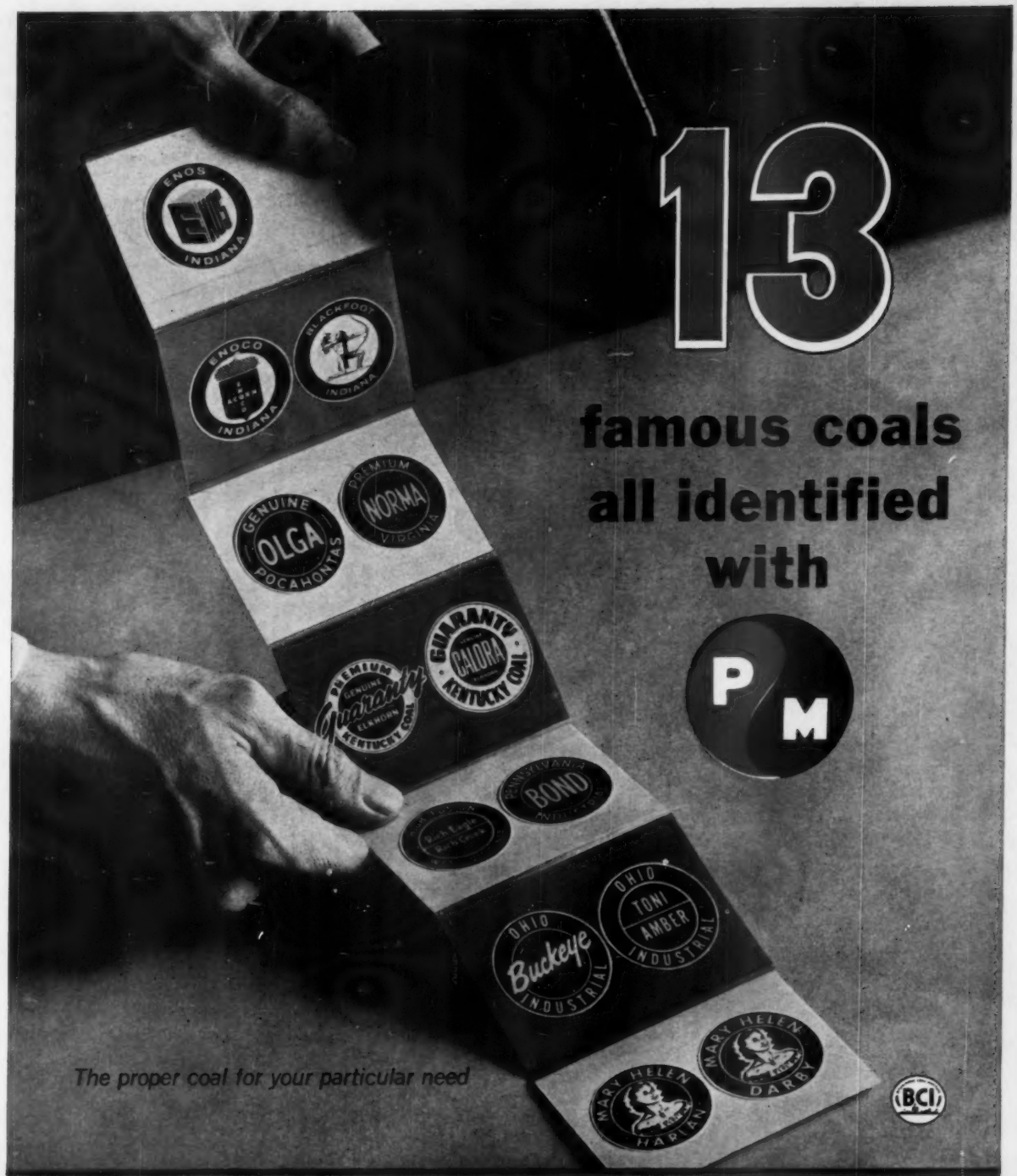

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HELPFUL WATER CONDITIONING DATA FROM BETZ

NEW ADVANCES IN ION

The development of ion exchange resins in the past few years has opened up broad new fields of scientific and industrial applications.

At the present time the field of ion exchange is in a state of rapid change and advancement. New resinous exchange materials are appearing with increasing rapidity, and it is sometimes difficult to keep abreast of the volume of technical papers on the many new developments. The application of ion exchange resins in such fields as pharmaceuticals, chemical processing, metal recovery, water softening, etc. is almost limitless. The development of ion exchange resins for use in the field of water treatment has been phenomenal and has contributed much to the technology of water treatment. A variety of water treatment processes have been the result, such as those listed in Figure 1.

1. Sodium Zeolite Softening
2. Cation Exchange by Hydrogen Zeolite
3. Hot Lime—Hot Ion Exchange Softening
4. Demineralization
5. Demineralization with Silica Removal
6. Dealkalization by Chloride—Anion Exchange

Figure 1—Ion Exchange Processes

History of Ion Exchange

The natural phenomenon of what now is called ion exchange was observed many centuries ago. It is generally recognized that the first formalized studies were conducted about 1850 and involved ion exchange properties of soils. These early studies concluded that ion exchange was not the same as physical absorption, but that equivalent quantities of ions were exchanged and that the materials in the soil making the exchange possible were the aluminum silicates.

Subsequently, considerable work was done on the silicates, both natural and synthetic. However, it was not until about 1900 that any significant commercial use was made of these exchange materials. While commercial applications of the siliceous exchangers increased, they were limited almost solely to hardness removal. The principal exchange materials were the greensands, although the synthetic silica gels occasionally were used. Somewhat later carbonaceous zeolites (sulfonated coal), capable of being operated on the sodium or hydrogen cycle were developed. The introduction of exchange materials that could be regenerated by acid to accomplish both hardness and alkalinity removal markedly increased the field of application of ion exchange processes for the treatment of water. Carbonaceous exchange materials are still employed on the hydrogen cycle, but their use on the sodium cycle has been supplanted by resins which have better regeneration efficiency and much higher exchange capacity.

Ion Exchange Resins

The first commercially available ion exchange resins were introduced in the late 1930's. The cation exchange resin was a condensation product of phenolsulphonic acid and formaldehyde. The anion exchange resin was a condensation product of polyamines and formaldehyde. Since that time there has been much improvement in stability and versatility of resins. Most resins produced today are prepared by copolymerization of styrene and divinyl benzene. The divinyl benzene has the effect of cross-linking the polystyrene, increasing both the stability and density of the copolymer. Before the copolymer can be used as an ion exchange resin, reaction groups must be added to the copolymer. The functional groups, which are attached, determine whether the resin will be a cation or an anion exchanger.

The types of ion exchange resins that are most widely used in water treatment are:

1. Strongly acidic cation exchange resins
2. Strongly basic anion exchange resins
3. Weakly basic anion exchange resins

The strongly acidic resins in commercial use are sulfonated copolymers of styrene-divinyl benzene, and the functional or active exchange sites are the sulfonic acid group (SO_3H). This resin is widely used on the sodium cycle (regenerated with sodium chloride) or on the hydrogen cycle (regenerated with acid). The resin is very stable and can be used at elevated temperatures up to 250 F. on the sodium cycle.

The strongly basic resins are of the styrene-divinyl benzene copolymer type with the functional sites being quaternary ammonium groups. Strongly basic resins are manufactured in two forms: Type I and Type II. The Type II functional groups have an ethanol group substituted for one of the methyl groups. The essential differences are that the Type I has better chemical stability and Type II has a better regeneration efficiency in the hydroxyl form.

The strongly basic resins are highly ionized and have the ability to remove weakly ionized substances such as silica and carbon dioxide as well as strong acids. These resins were first used commercially about 1948, and with their introduction the production of mineral free water by ion exchange became practical.

The weakly basic anion exchange resins utilize the copolymer of styrene and divinyl benzene. These resins are the polyamine type and the functional exchange sites are primary, secondary and tertiary amine groups. They are used mainly for the removal of strong acids. In practice, they are used as anion exchangers following strongly acidic cation exchangers in demineralization systems when the removal of silica is not essential. They have a somewhat higher exchange capacity and a better regeneration efficiency than the strongly basic resins.

Water Treatment Processes

It is possible with the water treatment processes listed in Figure 1 to select a method or combination of methods that will prepare a water to meet requirements for use over the complete range of boiler pressures. Figure 2 illustrates a typical raw water and the analysis of the water after treatment by some of the processes listed in Figure 1.

The effluent of Process 1 produces almost complete hardness removal leaving the other constituents unchanged. Process 2 removes both hardness and alkalinity and produces free mineral acid (FMA) equivalent to the sulfate and chloride content of the water. The combination of Processes 1 and 2 serves to neutralize the free mineral acid and to restore a portion of the alkalinity.

Process 3a shows the characteristics of the water after lime softening in the hot while Process 3b is the effluent after

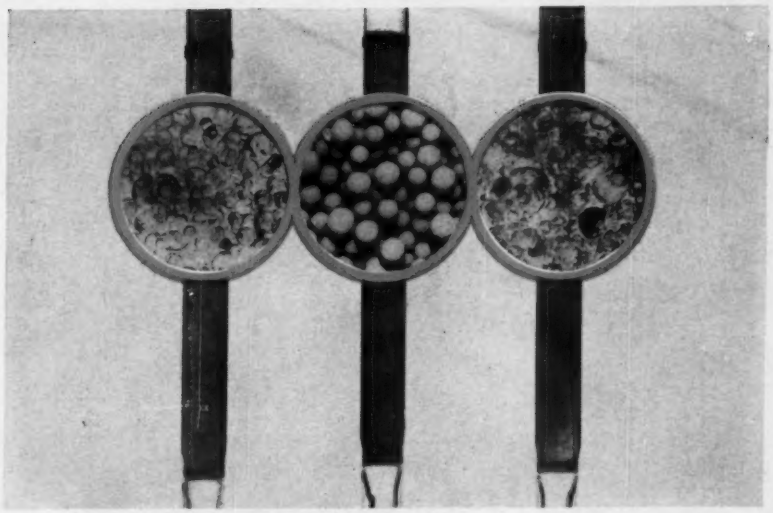


Figure 3—Betz INX-30 resists oxidants. The three columns were filled to the same level with two standard cation exchange resins and Betz INX-30. Exposed to 3% hydrogen peroxide, the standard exchangers swelled and showed severe physical damage; Betz INX-30 was unaffected except for a slight bleaching of color.

EXCHANGE RESINS

	Raw Water	1	2	1 + 2	3a + 3b		5
Total Hardness	150	0-2	0-2	0-2	18	0-2	0
Calcium as $CaCO_3$	110	0-1	0-1	0-1	15	0-1	0
Magnesium as $CaCO_3$	40	0-1	0-1	0-1	3	0-1	0
Alk. (P) as $CaCO_3$	0	0	0	0	13	13	0
Alk. (M) as $CaCO_3$	100	100	0	20	20	20	2
SO_4	40	40	40	40	40	40	0
Cl	10	10	10	10	10	10	0
SiO_2	15	15	15	15	3	3	.02
FMA			55				
Specific Cond. mmhos.							1.0
NOTE—results in ppm							

Figure 2—Typical Softener Processes

passing through ion exchange on the sodium cycle. Hardness, alkalinity and silica reduction have occurred. Finally, Process 5 provides complete demineralization, including silica removal.

The final selection of the process to be used will depend on the intended use of the water to be treated and the economics of the treatment costs, equipment costs and other factors.

Stability of Resins

The newer ion exchange resins are rugged materials which can operate over a wide range of pH, temperature, water characteristics and flow rates. They are far more stable than the natural greensands and synthetic zeolites. Many of the problems encountered with the older type materials can best be solved by replacement with these newer high capacity resins. While the newer resins are very stable they are not immune to fouling, mistreatment and deterioration. These resins must be applied within the limits specified and must be given proper care.

Copolymer chemistry, which has been responsible for the development of these more stable resins, has advanced to the point where resins can be more or less tailor-made to suit many applications. For example, a new resin identified as Betz INX-30 recently has been introduced. This high capacity, strongly acidic cation resin has physical and chemical stability unmatched by any previous cation exchange resin. Betz INX-30 is particularly recommended for applications where chemical or physical instability of standard cation exchange resins has resulted in short resin life.

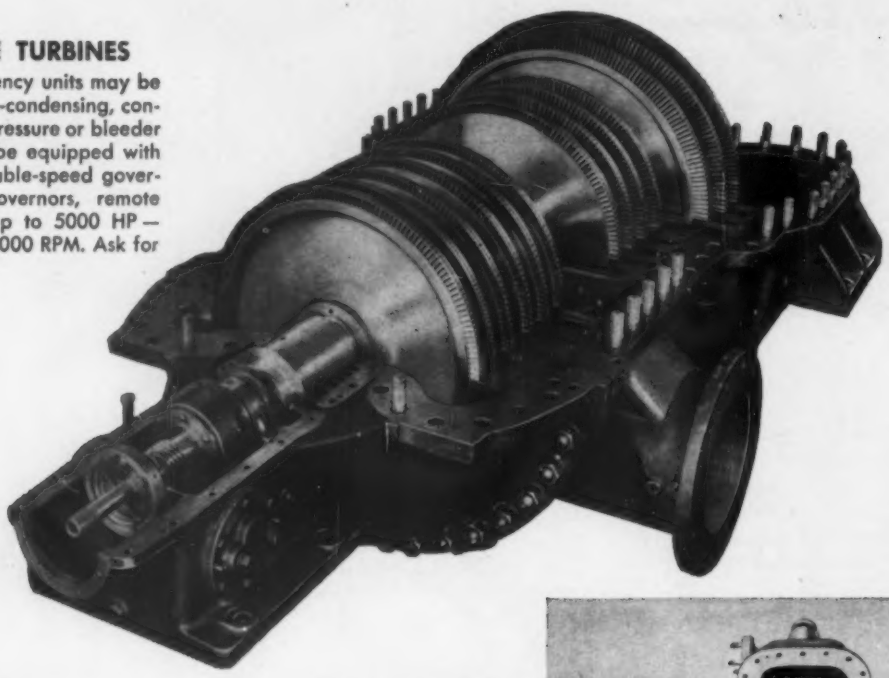
Your Betz Field Engineer will be pleased to discuss the application of ion exchange, the care and operation of the units and these new developments.

BETZ LABORATORIES, INC.
PHILADELPHIA 24, PENNSYLVANIA

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

MULTI-STAGE TURBINES

These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



There's a **Terry turbine** for every mechanical-drive requirement

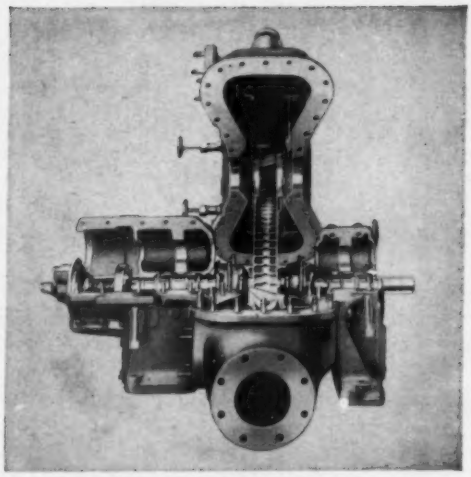
The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of *the leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

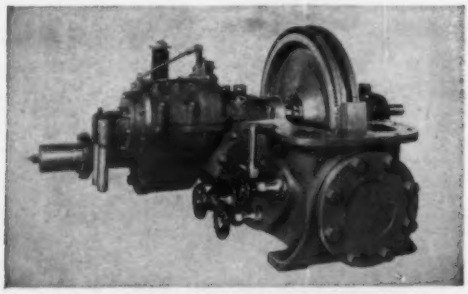
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



SOLID-WHEEL TURBINES

Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



AXIAL-FLOW IMPULSE TURBINES

Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.

FT-1209

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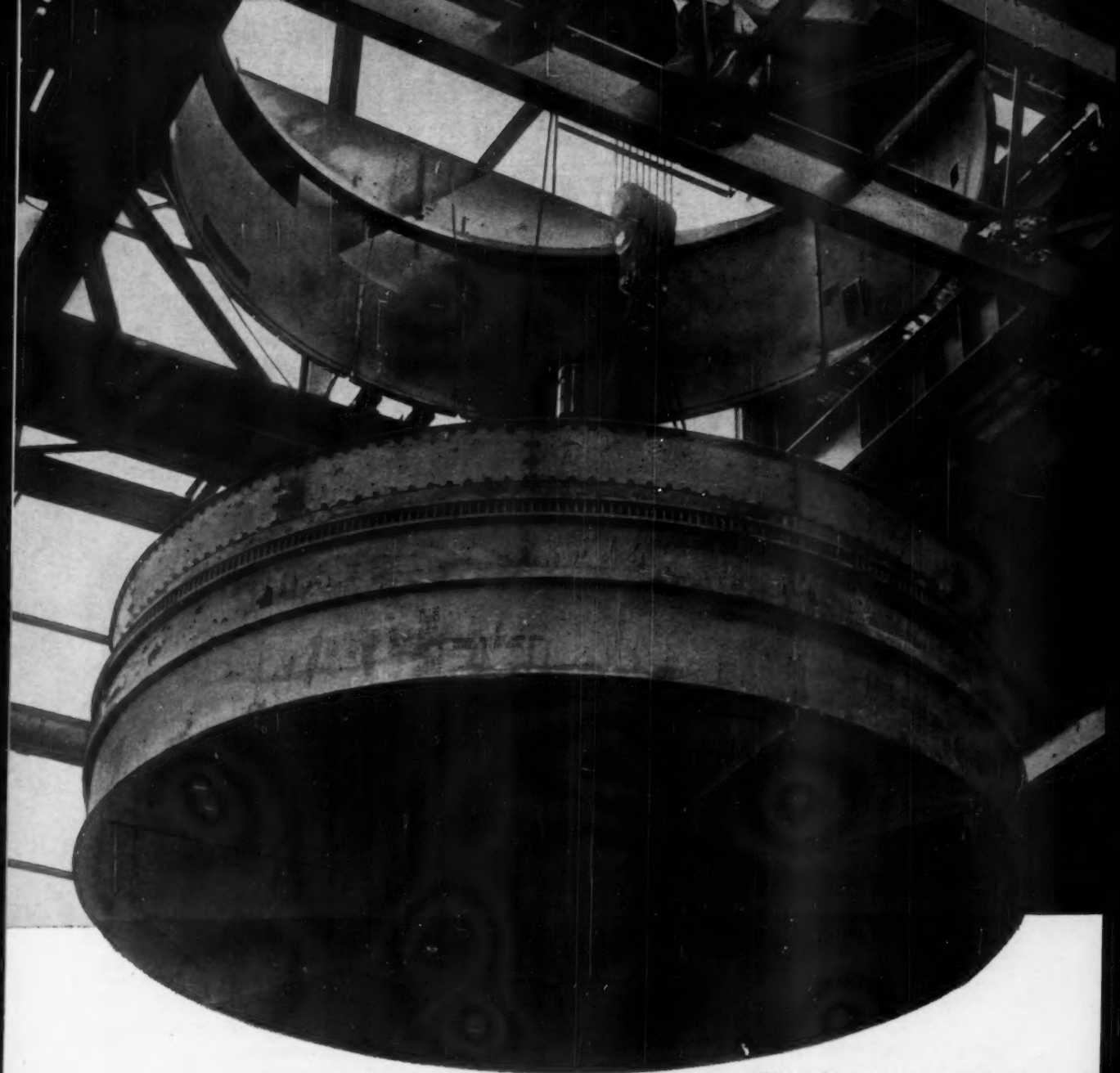

This 25' Ljungstrom rotor will contain a total heating surface of 128,000 sq ft. Continuous heat recovery by this unit will boost the temperature of incoming combustion air from 100°F to 585°F. Every 45-50°F thus returned as preheat increases boiler efficiency about 1%.

DOW RECOVERS 425°F WITH LJUNGSTROM® AIR PREHEATER

When Dow Chemical Company's Westside Power House at Midland, Mich., starts up their new 650,000 lb/hr boiler, more than half the waste heat will be *recovered* by a Ljungstrom Air Preheater. Dow's newest Ljungstrom (this is the eighth in their system) was designed to lower stack gas temperature from 700°F to 275°F, thus *recovering 425°F.* As a direct result, company engineers expect at least 10% reduction in fuel costs.

On process stills or boilers—or wherever large volumes of heat are involved—Ljungstrom Air Preheaters improve combustion, make fuel burn more completely. It's possible to save as much as 20% on fuel. ***All* major public utilities** use Ljungstroms; as do many major chemical and petroleum processing companies. Chances are, you, too, could benefit. For additional information, call or write The Air Preheater Corporation, specifying type of application.

THE AIR PREHEATER CORPORATION

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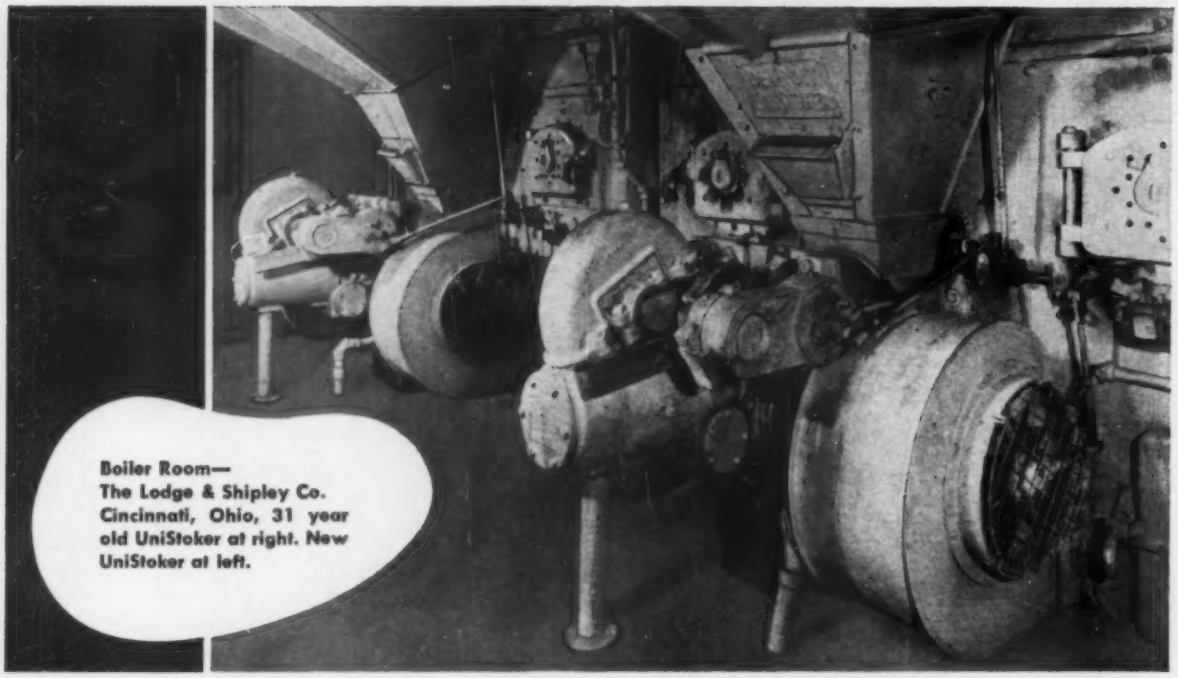
THEY JUST GO ON... AND ON*

31 Year old Detroit UniStoker is still serving and saving



Boiler Room—
The Lodge & Shipley Co.
Cincinnati, Ohio, 31 year old UniStoker at right. New UniStoker at left.

● A Detroit UniStoker installed at The Lodge & Shipley Co., Cincinnati in 1927 performed so well and proved the economy of UniStoker firing so conclusively that another UniStoker was purchased in 1958 when added steam capacity was needed to serve plant expansion.

EVEN MORE SIGNIFICANT—the original UniStoker after 31 years of service was doing such a good job it was deemed worthy of modernization.

Some of the up-to-date UniStoker features were added to it and many more years of efficient operation are expected.

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The Complete Detroit Line of Underfeed and Overthrow Spreader Stokers provides a type and size for almost any boiler from 3,000 to 400,000 pounds of steam per hour capacity.

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Current Catalogs

Instruments and Controls

101 Multi-Point Controllers — Eight-pp Instrument Section 52, issued by Thermo Electric Co., Inc., describes a multi-point controller for two-position control of up to ten industrial processes; three-position control of five processes; constant control of a single process; manual balance indication of exact process conditions at each point and monitoring facilities.

102 Digital Telemeter System — In Bulletin GEZ-3312, General Electric Co. describes fast and accurate telemetering of HKWR readings from remote locations to central load dispatch office. Relates operating features of digital telemetering systems with descriptive schematics, system specifications and available accessories.

103 Versatile Recorder — A recorder as small as an ordinary panel meter and designed to record any variable in any industry is featured in 8-pp Publication 3057 by Thomas A. Edison Industries. Operation details, and specifications are included.

104 Dial Thermometers — Bi-metal actuated dial thermometers are illustrated and described by Manning, Maxwell & Moore, Inc. in 20-pp Catalog 155. Construction features are detailed and sizes, stem lengths, dimensions, weights and general specifications included.

105 Temperature Transmitter — Bulletin 98293, 6 pp, describes the Sensaire temperature transmitter of Taylor Instruments Companies. Fast response, flexibility of range adjustment, simple operation and inexpensive compensation for thermal lags are discussed. Special features of gas-actuated and mercury-actuated types are also covered.

106 Sight Flow Indicators — Flapper and rotary types of sight flow indicators are described by Schutte and Koerting Co. in Bulletin 18W. Covers construction details, dimensions, operating limits and includes specifications.

107 Combustion Indicator — Eight-pp Bulletin Q-2 released by Selas Corp. of America describes a continuous reading instrument which indicates changes in flame characteristics caused by variations in air/gas mixture. Specifications and operation are detailed, including performance curves, schematic diagram, internal photo.

108 Climate Control Station — Functions, components and benefits of Electronic control centers are described in 8-pp Form F-8031-1 Barber-Colman Co. Power engineers concerned with automatic temperature control systems can obtain information on graphic panel, Selectronic and identification control centers from this brochure. Remote temperature indication, recording and control point adjustment by electric and electronic instruments are described. Also discussed are additional optional functions, such as control of lighting.

109 Air Conditioning Controls — Refrigeration, air conditioning and heating controls are illustrated and described by Furnas Electric Co. in Bulletin 05-BI. A complete line of contactors and starters is illustrated and described.

Water Conditioning

110 Boiler Water Analysis — This data sheet released by Technicon Controls, Inc. outlines a means of securing continuous analysis of ammonia content of boiler waters down to parts per billion. Included is a proposed methodology for determining ammonia content of gaseous streams.

111 To Minimize Slag — A fuel oil treatment designed to minimize slag and corrosion in boiler systems is described by Nalco Chemical Co. in Bulletin E1–159. How product improves heat transfer and protects the convection and "cold end" of boiler furnaces is outlined. A case study and methods of application are included.

Pumps, Compressors

112 Chemical Handling Pump — Horizontal end-suction centrifugal pumps featuring maximum interchangeability of parts are described in 16-pp Bulletin 725.8 by Goulds Pumps Inc. Applications in chemical processing are detailed, and specifications, bearing life information, sectional views, composite curves and dimensional details included.

113 Improved Centrifugal Pump — Detailed information on solids-handling and acid pumps designed to prevent wear of the shaft and leakage at the gland is presented in 20-pp Bulletin VP-061, released by The Galigher Co. Includes cutaway views showing component details, as well as dimensional diagrams, selection tables, performance curves, and other data.

114 Impervious Graphite Pumps — Catalog Section S-7253 describes Karbate impervious graphite Type F centrifugal pumps. Four basic sizes, capacities to 140gpm and heads to 67 ft, are described. A cutaway shows features of the carbon-to-carbon rotary seal. Pump characteristic curves plot total heat, bhp and net positive suction head against gpm. Dimension sketch and table cover 20 available models of the motor-mounted pumps. Bulletin is offered by National Carbon Co., Div., Union Carbide Corp.

115 Submersible Pumps — Condensed and compact, the 1961 catalog of Kenco Pump Div. is a quick but complete reference on uses of submersible pumps. Featuring thumb nail illustrations of typical applications, lists physical dimensions, pumping capacities, electrical data and specific features for each pump.

116 Metering Pumps — Design and construction features of metering pumps designed for single or double simplex service are outlined by Wallace & Tiernan Inc. in 8-pp Catalog 420.100. Lists standard materials of construction, capacity-pressure data, includes mounting diagrams.

117 Submersible Turbine Pumps — Heavy-duty submersible turbine pumps are described in The Deming Co.'s Bulletin 6730. Capacity tables, installation diagrams, performance data and cutaway showing inside details are included.

118 Packaged Compressors —Operational and design features of packaged compressor stations suitable for field gas gathering, off-shore mounting, gas lift, repressuring, recycling, plant feeders, refining, secondary recovery, gas transmission, natural gasoline plants, and multi-service applications are detailed by Clark Bros. Co. in 6-pp Bulletin 191. Cutaway view, specifications and dimensional information are included.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 103 and 104.

119 Single Stage Compressors — One and two-cylinder single stage air compressors are featured by The Wayne Pump Co. in 8-pp Form 123. Includes detailed selection data and specifications.

Lighting, Communication

120 MV Lighting Facts — Facts showing why this manufacturer's mercury vapor industrial lighting is a worthwhile choice for industrial plant lighting installations are presented in this 24-pp booklet by Holophane Co., Inc. Using case history comparisons to point up efficiency of the equipment, book shows its use in a broad range of industrial applications and explains advantages.

121 Microwave System — This 12-pp bulletin of Lynch Communication Systems Inc. describes a flexible microwave system for low-cost transmission, such as telephone, telegraph, teleprinter, protective relaying and telemetering, supervisory control, monitoring, data and other communication signals. Perfromance specifications and ordering information included.

Valves, Traps, Piping

122 Fire Safe Ball Valves — Described in this product bulletin by The Jamesbury Corp. are "fire safe" ball valves for hydrocarbon service at process temperatures below 400 F. Advantages are detailed along with specifications.

123 Air Conditioning Valves — Illustrated and described in 8-pp Bulletin 272-A issued by American-Standard Control Div. are air conditioning control valves which eliminate need for pneumatic lines or electrical connections. Features and advantages of the valves are detailed and specifications included.

124 Steam Trap Selector — This 32-pp impulse steam trap selector for petroleum processing equipment, released by Yarnall-Waring Co., contains detailed information on how to select, size and install steam traps. Includes trap recommendations, capacity tables, piping diagrams.

125 Jacketed Pipe, Fittings — Bulletin J-57, 8 pp, presents pipe and fittings designed to maintain uniform temperature, hot or cold. A publication of Hetherington & Berner Inc., bulletin illustrates jacketed spring loaded plug valves; all-jacketed gate valves, ball check valves and others; jacketed welded steel fittings; jacketed flexible hose. Also illustrates and gives capacities for jacketed pumps.

Automation

126 Automatic Programming Systems — Characteristics of automatic programming systems for commercial and scientific computer applications are described by Bendix Computer Div. in Bulletin AR-1060. Includes partially coded illustrations of typical problems.

127 Computer Control — Applications of computer controls in a variety of industrial processes, from petroleum and chemicals through power, cement and research, are detailed in this 12-pp bulletin by TRW Computers Co. Describes the RW-300 digital computer designed specifically for process control.

128 Before the Computer Comes — Prepared by the Philco Corp., this 8-pp booklet tells what to do before installing an electronic data processing system. In non-technical language, booklet describes system analysis, specifications, design and full operation of the computer.

Mechanical Power Transmission

129 Power Transmission Equipment — This 24-pp catalog (GC-101-F) introduces Browning Mfg. Co.'s broad line of power transmission equipment. Bushings, sheaves, pulleys, belts, sprockets, chain, couplings and related equipment are illustrated along with features, sizes, other ordering information. Approximately 10,000 stock items are presented, and company points out that with the 2835 items using split taper bushings, some 102,528 combinations are possible from stock.

130 Adjustable Speed Drives — Eight-pp Application Data 5560 contains detailed information on Westinghouse Electric Corp.'s adjustable speed drives for pumping applications. Contains application diagrams, efficiency curves and mechanical details.

131 Roller Chain Guide — Catalog 760, 120 pp, on stock roller chain, sprockets and couplings of Diamond Chain Co Inc. carries new ARSCM hp ratings. With the new higher ratings, roller chain can be used in more applications because of the greater loads which can be transmitted at higher speeds. In addition to engineering data, this catalog gives information on company's new products in power transmission and conveying fields, including Dura-Weld top plate conveyor chain, Tef-Flex heavy duty roller chain, Micropitch miniature roller chain, and Hi-Cap flexible couplings. Catalog is available to qualified power engineers, please state your title.

132 Belt Interchange Guide — This interchange guide of Manheim Mfg. & Belting Co. lists outside circumference, top width and number of links of variable speed belt required for equivalent sizes of Dayton, Gates and other rubber belts and Reeves wood block belts. Data on how to measure, install and how to compute price of Types I through V MVS belt are included in the guide.

133 V-Belt Clutch — Featured in 8-pp Catalog 40 are V-Belt Clutch Co.'s lever action clutches for industrial applications. Includes specifications and selection information, optional shaft requirements, pulley sizes, actuating devices, and applications for general purpose clutches, heavy-duty clutches, ball-bearing clutches and special duty clutches.

Fans, Blowers, Ventilating

134 Ventilating Fans — Packaged ventilating fans for commercial and industrial applications are featured in Bulletin 1160 issued by Modine Mfg. Co. Contains dimension and performance charts and explains advantages of direct drive design.

135 Rotary Positive Blowers — Twelve-pp Bulletin S88-A tells how Series 88 rotary positive displacement blowers of Suterbilt Corp. provide constant metered quantities of gas or air, even against varying pressures. Explains operating principles and tells how design permits mounting in several positions. Dimensions and capacity data are provided and photos show custom package units designed for special requirements.

136 Duct Diffuser — Illustrated and described in this product bulletin by United Sheet Metal Co. Inc. is a duct system with diffusers in the wall for distribution of warm and cold air throughout a plant. Features and advantages of the duct diffusers are detailed.

137 Roof Ventilator — Direct drive centrifugal roof ventilators are described by American-Standard Industrial Div. in 8-pp Bulletin 4104. Illustrates and describes design features and operating characteristics and includes selection and rating tables and other data.

Electrical

138 Worm Gear Motors — Right-angle worm gear motors designed to give maximum of performance for a range of load requirements are featured by U. S. Electrical Motors Inc. in Form F-1971. Includes ratings and dimensional data for single and double reduction types, as well as a cutaway view showing component features and details.

Postage-free cards for odering catalogs are on page 103. You may also use the cards to order literature mentioned in the ads.

139 Motor Control Center — Features and advantages of The Rowan Controller Co.'s motor control center which consists basically of an assembly of safety jack combination starters on a free-standing vertical section are detailed in this 8-pp bulletin. Describes components and illustrates typical installations.

140 Grouped Power Centers —Bulletin GET-3041, 16 pp, gives detailed application data on Cabinetrol grouped power control panels, which utilize standard components arranged as required. Provides specifications on squirrel gage, synchronous-motor, wound-rotor-motor, and d-c motor combination starters, as well as incoming line breakers, secondary breakers and feeder circuit breakers. Prepared by General Electric Co., booklet also gives overload relay heater specifications.

141 Unified Control — Described in Bulletin 1260 is Lake Shore Electric Corp.'s "unified control," combining generator control circuits, transfer switch, and optional automatic engine control panel and battery charger. Also illustrated are auxiliary controls, including differential voltage relay and others.

142 Switchboard Instruments — Bulletin GEZ-3308, 12 pp, describes General Electric Co.'s low-cost Type AB-30 and DB-30 switchboard instruments. Includes information relating to ranges covered, instrument burden data, dimensions and panel drilling layouts plus external connection diagrams and other pertinent specifications.

143 Door Interlock Switches — Illustrated and described in Data Sheet 186 are door interlock switches for use as safety devices on hazardous electronic equipment. Prepared by Micro Switch, Div., Minneapolis-Honeywell Regulator Co., bulletin provides mounting dimension drawings, mechanical characteristics, electrical ratings.

144 Precision Switches — Twenty-pp Catalog 104 of Micro Switch, Div., Minneapolis-Honeywell Regulator Co., covers a representative selection of precision switches for industrial, data processing, electronic and other applications. Contains photos and condensed descriptions of over 200 items, including miniature switches, special purpose types, electronic switch-circuit assemblies, lighted push-button switches, toggle switches, limit switches, proximity and mercury switches.

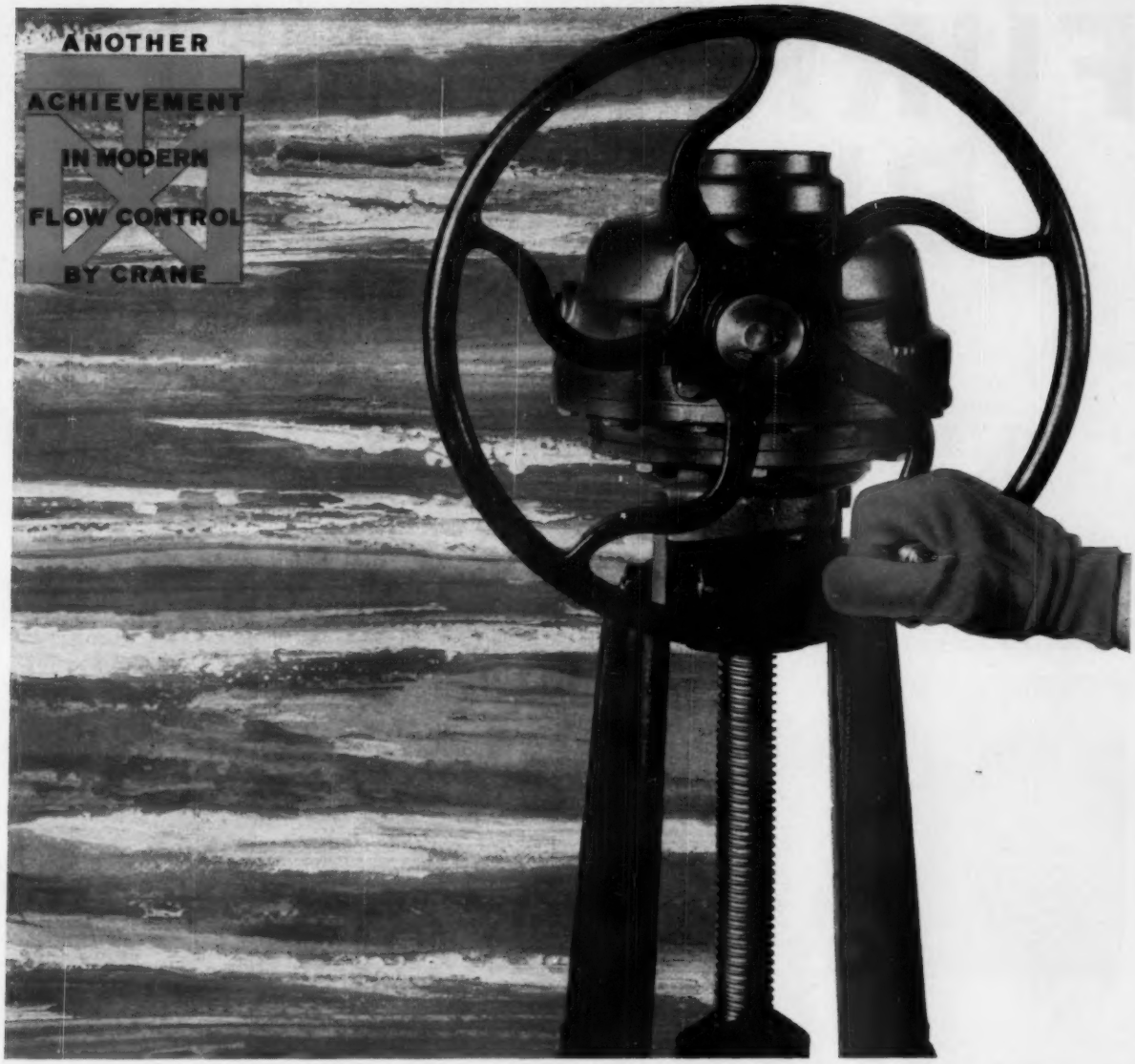
145 Outdoor Magnetic Starters — Bulletin GEA-5504F describes General Electric Co.'s outdoor combination magnetic starters for control of irrigation pumping motors. Heater selection table, connection diagram and dimensional data are included.

146 Starters for FHR Motors — Illustrated and described in 8-pp Bulletin 10-B1 is Furnas Electric Co.'s line of manual starters for fractional horsepower motors. Design and construction features are detailed, and selection tables and dimensional diagrams are included.

147 For System Protection — Cast-in-concrete reactors for use on electric utility and industrial plant distribution systems are illustrated and described by General Electric Co. in 16-pp Bulletin GEA-976E. Includes data on ratings, dimensions and weights, application information, and description of metal enclosures.

148 Current-Limiting Reactors — Cast-in concrete reactors for use on electric utility and industrial plant distribution systems rated 34,500 v and below are illustrated and described by General Electric Co. in 16-pp Bulletin GEA-976E. Includes data on ratings, dimensions and weights, application information.

149 Current Limiting Fuses — Bulletin GEA-6319D, 8 pp, describes applica-



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CRANE'S NEW CONVERTO-GEAR OPERATOR

gives you torque enough to tame a torrent. In a matter of minutes, you can power up a wide range of Crane iron and steel gate valves: OS&Y's with ball-bearing or split yokes, rising and non-rising stem types with stems up to 2½-inch diameter.

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AT LARGE EASTERN UTILITY OIL-FIRED BOILERS

Nine months ago, a large eastern utility *replaced firebrick* with FURNACE BLOK in the burner and target walls of oil-fired boilers. As a result of drastically lower erection costs and excellent service life, utility will now standardize on FURNACE BLOK in these walls.

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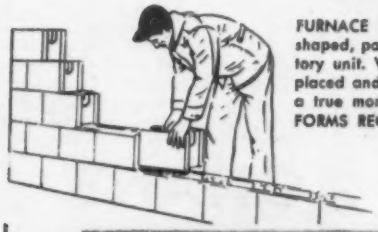
Burner wall, 8 ft. high x 26 ft. wide, of oil-fired boiler showing perfect condition after nine months' service.



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tion, operation and features of General Electric Co.'s Class J, H and L current limiting fuse for short circuit and overcurrent protection as applied to motor control centers, etc. Contains photos, curves, dimensional and rating tables.

150 Fault Indicators — Described in Bulletin SP3 by Line Material Industries are fault indicators designed for indication of faults on underground distribution systems. Covers application, features, and ordering and dimensional data.

151 Silicone Insulated Cable — Characteristics of various types of silicone-insulated wire and cable manufactured by Boston Insulated Wire and Cable Co. are discussed in this product bulletin. Single and multi-conductor cable are covered, including power and lighting cable, hook-up wire, ignition cable and others.

152 For Hazardous Locations — Condulets for hazardous locations are illustrated and described by Crouse-Hinds Co. in 60-pp Bulletin 2722. Code articles 500–503, and 510–517 are quoted, along with recommendations for condulets meeting various requirements. More than 300 product photos, installation photos and drawings are provided. Book is a valuable reference for planning electrical installations in hazardous areas.

153 Selecting Contact Devices — How to select contact devices and impulse generators is told by General Electric Co. in 12-pp Bulletin GET-3048. Formulas, graphs and tables aid in determining correct contact devices for demand applications. Covers methods of choosing proper device to transmit electrical impulses from a watt-hour meter to a demand meter. Also provides formulas for converting from contact devices on meters with ball- or pivot-type bearings to equivalent devices on magnetic-suspension meters.

When ordering catalogs don't forget that the Reader Service Cards can also be used to request any literature offered in the ads

154 Pushbutton Stations — Standard and heavy-duty pushbutton stations are illustrated and described in General Electric Co.'s 8-pp Bulletin GEA-6544A. Includes dimensions and ordering information, and callouts showing features of typical heavy-duty pushbutton station.

Other Equipment

155 Automatic Sampler — Described in Bulletin S-056 by The Galigher Co. is an automatic sampler designed for representative sampling of liquid, slurries, and solids. Discusses requirements of accurate machine sampling, and describes applications in coal sampling and other automatic sampling areas.

156 To Peek Into Pipes — This catalog sheet of General Precision, Inc., illustrates, explains and gives specifications for a closed-circuit television camera designed to explore pipes as small as 4 in. in diameter. Camera has built-in light source of 30 ft-c at 1 ft, and a removable rotating mirror for axial or radial viewing. Lists some typical industrial applications for the pipeviewing camera.

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To find the right valve for power plant installation, just call Powell. It's that simple, since Powell can supply just about any type of valve you may need to control water, oil, gas, air, steam or corrosive fluids.

What's more, you don't have to wonder about Powell performance. It's built-in through sound engineering, development, materials and workmanship . . . and proved day in, day out.

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THE WM. POWELL COMPANY CINCINNATI 22, OHIO

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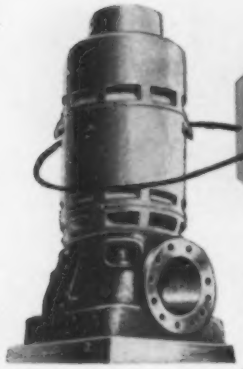


Another Important FIRST By "VERTI-LINE" PUMPS...

HIGH-TEST "MOLY" IRON NOW "STANDARD" IN ALL Verti-Line Pumps

Again Layne & Bowler sets new standards of quality construction for the pump industry... *longer-life Molybdenum-Iron is now "standard" construction – at no extra cost – in* ALL *"Verti-Line" pump cases and other cast iron parts!*

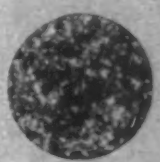
"Moly" iron has a more uniform grain structure, is far more corrosion-resistant than is the gray iron normally used in pump construction. Therefore, you get longer operating life, lower maintenance costs, when you specify Layne & Bowler "Verti-Line" Pumps!

COMPARE!

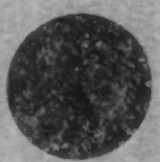
GREY IRON

MOLY IRON

▶ **These Photomicrographs,** both made at exactly the same enlargement (100x), show the structure of gray iron (left) vs. "Moly" iron (right). Note the long "stringers" of soft graphite characteristic of gray iron – stringers that weaken the metal and lead to early breakdown of the iron matrix. Note (right) how "Moly" iron is far more homogeneous, with uniform distribution of the iron matrix for longer pump life.



GREY IRON



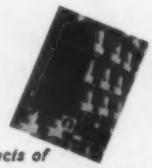
MOLY IRON

▶ **These "Fractures"** (views across fractured surfaces) clearly show the much coarser grain of gray iron (left) vs. the uniformly fine grain of "Moly" iron (right.) Although Layne & Bowler's fine-grained "Moly" iron assures much longer pump life than the gray iron used in other pumps, *you now pay nothing extra for this important "Verti-Line" advantage!*

Layne & Bowler has its own modern foundry – therefore can standardize its foundry runs to "Moly" iron techniques *at no extra cost to you.*

And if your operations are extra tough, "Verti-Line" pumps are available in special "Moly" irons having a Brinell as high as 350... a Tensile as high as 50,000 psi!

Remember – "Moly" iron is just one of many major pump advancements built into every "Verti-Line" pump – advancements that assure top performance for your pump dollar when you specify "Verti-Line" Pumps!



For more details on the many "Verti-Line" advantages, write for Bulletin #200.

Verti-Line Pumps are exclusive products of

LAYNE & BOWLER PUMP COMPANY
LOS ANGELES 22

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157 Cold Repair System — Included in this file folder type catalog of Metalock International, Inc. is literature on cold repair systems for cracked and broken castings and forgings. Applications of this type of repair service to compressors and cylinders, steam engines, turbines, mills and blowers, presses, shafts, gas and diesel engines and machinery parts are described and illustrated.

158 Why Model the Plant — The whys and hows of using scale models as an engineering tool in construction projects is outlined from preliminary design through erection and equipment installation in this 6-pp booklet of Industrial Models, Inc. Covers preliminary studies and use of "do it yourself" kit, basic model, piping design, use of material take-off. Also covers use of model in training personnel.

159 Supercharged LSV Engines — Operating characteristics of 12- or 16-cylinder supercharged LSV engines for various fuel requirements — gas, straight diesel, dual fuel or tri-fuel — are detailed in Bulletin 77-2 of Cooper-Bessemer Corp. Specifications, rating curves and dimensional drawings are included.

160 Efficient Plan Filing — Twelve-pp Catalog 3-60 of Plan Hold Corp. describes vertical and roll filing equipment for plans, blue prints, maps and drawings, as well as small materials. Advantages of the vertical system are explained and the binder clamps illustrated. Rolling stands, caddy racks, combination cabinets and special equipment are described. Also shown are stack roll files for materials up to 5 ft wide. Current price list included.

161 Exhaust Heat Recovery — Detailed information on exhaust heat recovery and silencing equipment is presented by Engineering Controls, Inc. in this 16-pp catalog. Illustrates and describes water heating exchangers, extended surface exchangers and other products, with heat balance data, piping, control schematics.

If the type of catalog you need isn't described among these new publications, try the Reference File of Commercial Literature at the back of the book. You'll find many excellent standard booklets there—yours for the asking.

162 Industrial Odor Control — Methods of industrial odor control and selection of counteractant odors against specific malodors are detailed by Rhodia Inc. in this 16-pp bulletin. Covers plant odor as well as product odor control.

163 For Low Pressure Heating — Described by American-Standard Industrial Div. in 8-pp Bulletin 649B is a line of boilers for low pressure heating of commercial and industrial buildings. Includes tabulated data on ratings and dimensions, as well as typical specifications and selection data for available heating coils and induced draft fans.

164 Liquid Blending Systems — New concepts in continuous line blending are detailed in 8-pp Bulletin 650 by Blackmer Pump Co. Explains advantages and operating principle, and includes schematic layout of components and case histories of typical applications.

NOW
THE FAMOUS "NO MAINTENANCE" PRESSURE REDUCING VALVE WITH NEW STEEL BODY

The Leslie GP-type pressure reducing valves are recognized as the simplest, most rugged, most maintenance-free ever made. Sold under Leslie's famous 3-year no-maintenance guarantee, they have so far been available with cast iron or cast bronze bodies only.

To satisfy the heavy demand for GP performance and construction features in 150, 300 and 600 lb. steel-body valves, here is the new Class GPS valve in carbon steel and alloy steels for steam, air, gas and other vapors.

The design still uses only two moving parts—a Spiroflex diaphragm and the main valve. These are virtually indestructible. There is nothing to wear out.

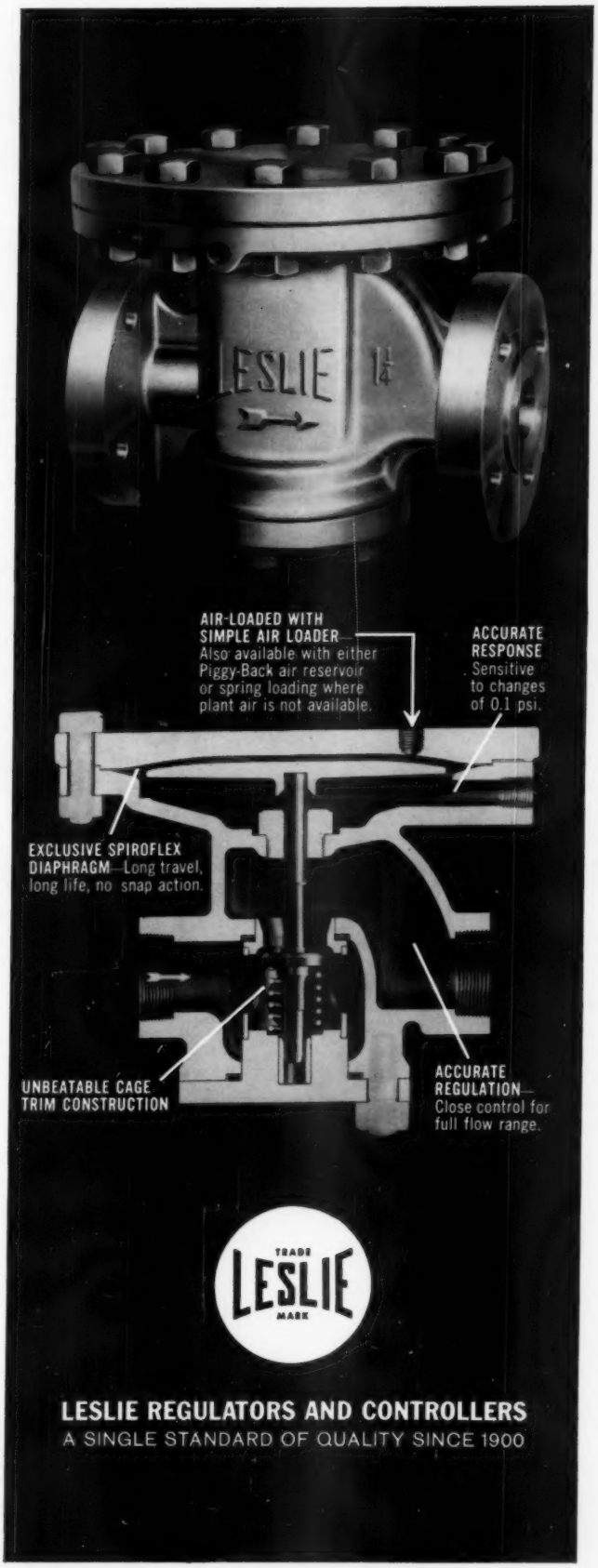
The low-stress diaphragm is the patented Leslie-Spiroflex®, which flexes like rubber but resists temperature as only a metal diaphragm can. Look at the cage trim construction—proved in Leslie-Lifetime control valves. Hardened stainless steel main valves seat on easily renewable, "permanent" type, stellited seat inserts. An unbeatable combination for long, trouble-free life.

The man to show you how much money this design will save you is your nearest Leslie Engineer. He is listed in the Yellow Pages under "Valves" or "Regulators." You will also want to send for our Product Data Sheet No. 611.

SPECIFICATIONS—Reducing Valve, GPS Classes

Sizes: ½" to 2" screwed or welding ends, or 150 lb., 300 lb. and 600 lb. flanges in carbon steel and alloy steels. Inquire about 2½ to 4" sizes soon to be available.
Diaphragm: Leslie-Spiroflex®, Stainless Steel.
Main Valve: Type 440C Stainless Steel, hardened.
Seat Ring: Stainless Steel, Stellited.
Stem Guides: Gun Metal Bronze (top and bottom guided).
Main Valve Spring: Inconel.
Inlet Pressure Range: 600 psi, 600°F.
Reduced Pressure Range: 0-300 psig.
Minimum Pressure Drop across Valve: ½ psi.

Leslie Co., 702 Grant Ave., Lyndhurst, New Jersey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AIR-LOADED WITH SIMPLE AIR LOADER— Also available with either Piggy-Back air reservoir or spring loading where plant air is not available.
ACCURATE RESPONSE Sensitive to changes of 0.1 psi.
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A SINGLE STANDARD OF QUALITY SINCE 1900

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TURNER STATION
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Unit No. 4 is a 600/000 lb/hr
RILEY TURBO FURNACE BOILER

Design Pressure — 1750 psig
Superheat/Reheat — 1000°F
Fired by Natural Gas and Oil
Efficiency up to 90% on oil — 86% on gas.

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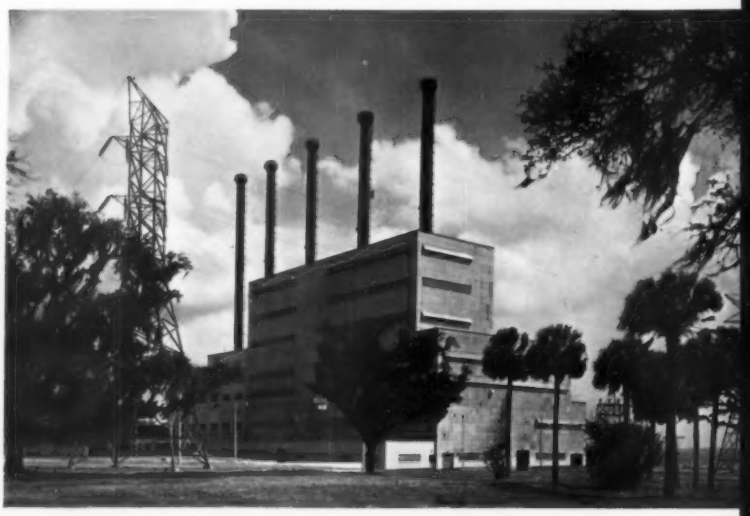
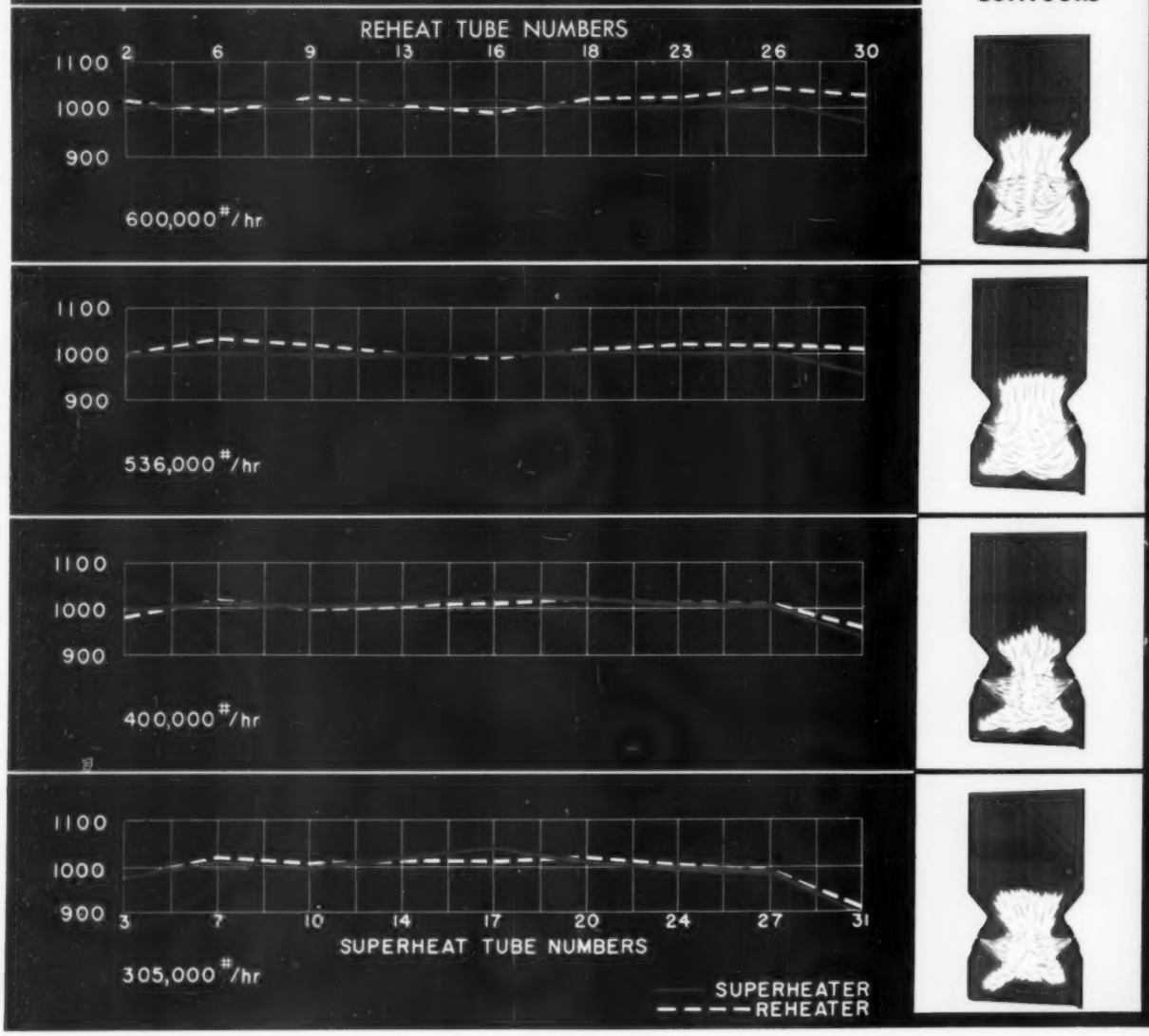


FINAL SUPERHEAT-REHEAT EXIT TUBE TEMPERATURES



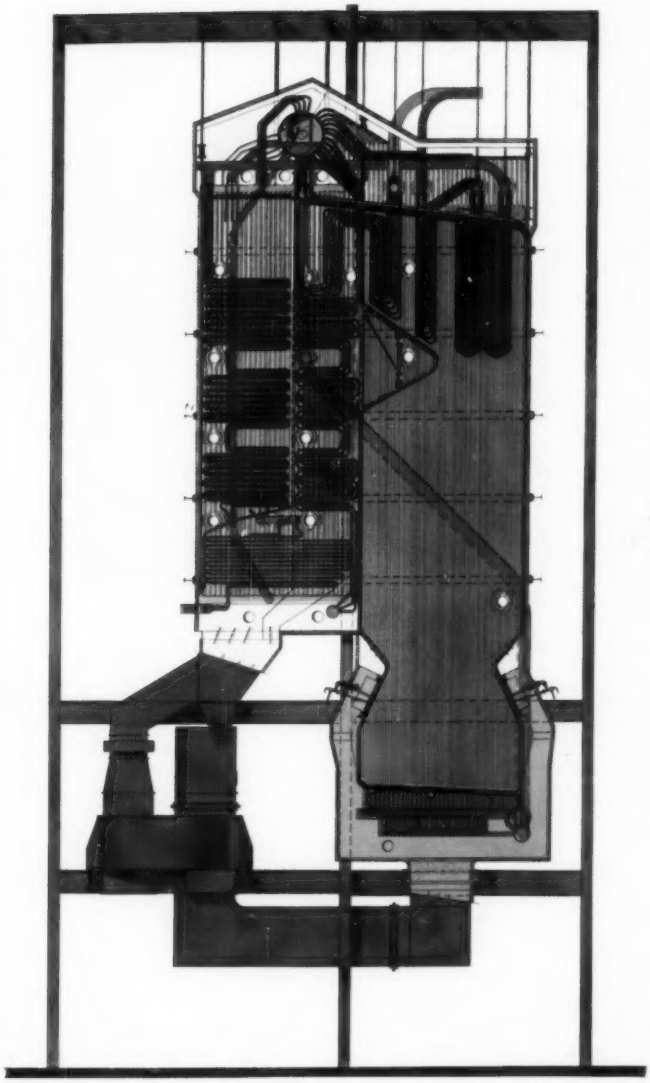
FLAME CONTOURS

RILEY TURBO FURNACE

produces extremely uniform furnace exit temperature at

FLORIDA POWER CORPORATION

Uniform, safe gas temperatures across the full span of a boiler's high temperature superheater and reheater is a vital requirement for trouble-free operation. With a Riley Turbo Furnace this objective is attained . . . without use of costly auxiliary methods for distributing furnace gas.



In the Riley Turbo Furnace all fuels — gas, oil, coal — are burned at the base of the furnace well away from superheater and reheater with combustion taking place evenly from side wall to side wall. Combustion gas rises within the furnace envelope in a uniform side wall to side wall column resulting in minimum variation in metal skin temperatures of all superheater and reheater elements. Temperatures are well within safe alloy limits to assure long tube life. Proof of such performance is provided in the accompanying curves. Flame contour diagrams illustrate combustion uniformity at each load level.

The Turbo Furnace boiler is capable of operating over a 6-1 load range with oil or gas firing with all burners in service on automatic control and without burner adjustment. Design and operating characteristics of the Turbo Furnace also provide more rapid and uniform water and steam circulation, help to maintain a clean furnace, and minimize flyash and air pollution problems.

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STEAM GENERATING AND
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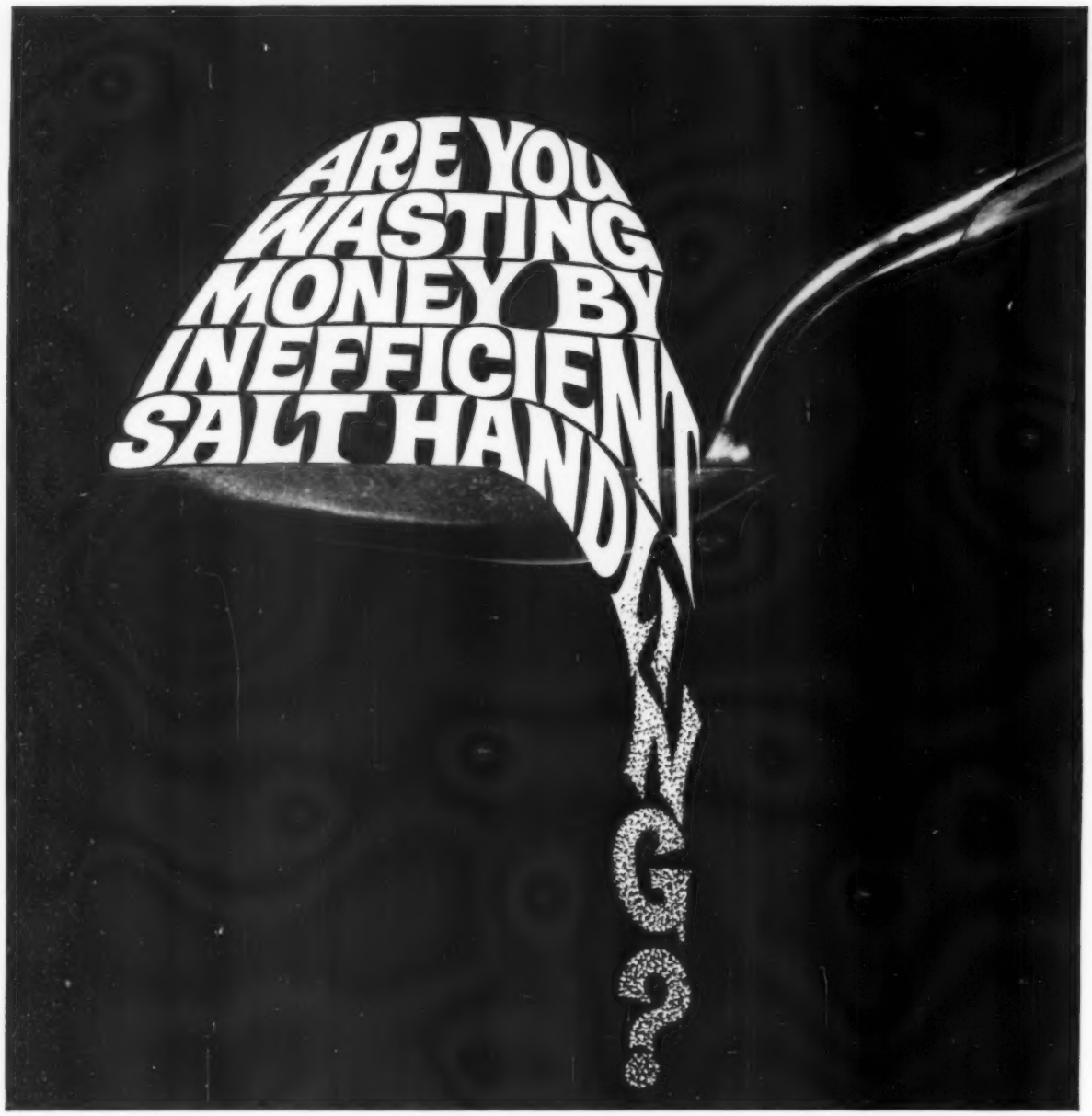

LET MORTON SALT COMPANY SPECIALISTS IN SALT ADVISE YOU WITHOUT COST OR OBLIGATION! Nowadays there are almost as many ways of handling salt as there are companies using it.

Obviously some are more efficient than others. But often it takes a real expert in materials handling to know which of two or three methods is *most* efficient.

Because of its multiplant operations from coast to coast, Morton Salt Company has gained wide experience in all phases of salt handling. Today Morton maintains a department whose sole function is to advise on salt handling problems. There is no cost or obligation whatsoever for this service.

Just fill out and mail the coupon at right, and you will be contacted soon! Do it now—it may mean considerable savings plus increased efficiency for you!

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THE ONLY NATION-WIDE SALT COMPANY
FILL OUT THIS COUPON NOW

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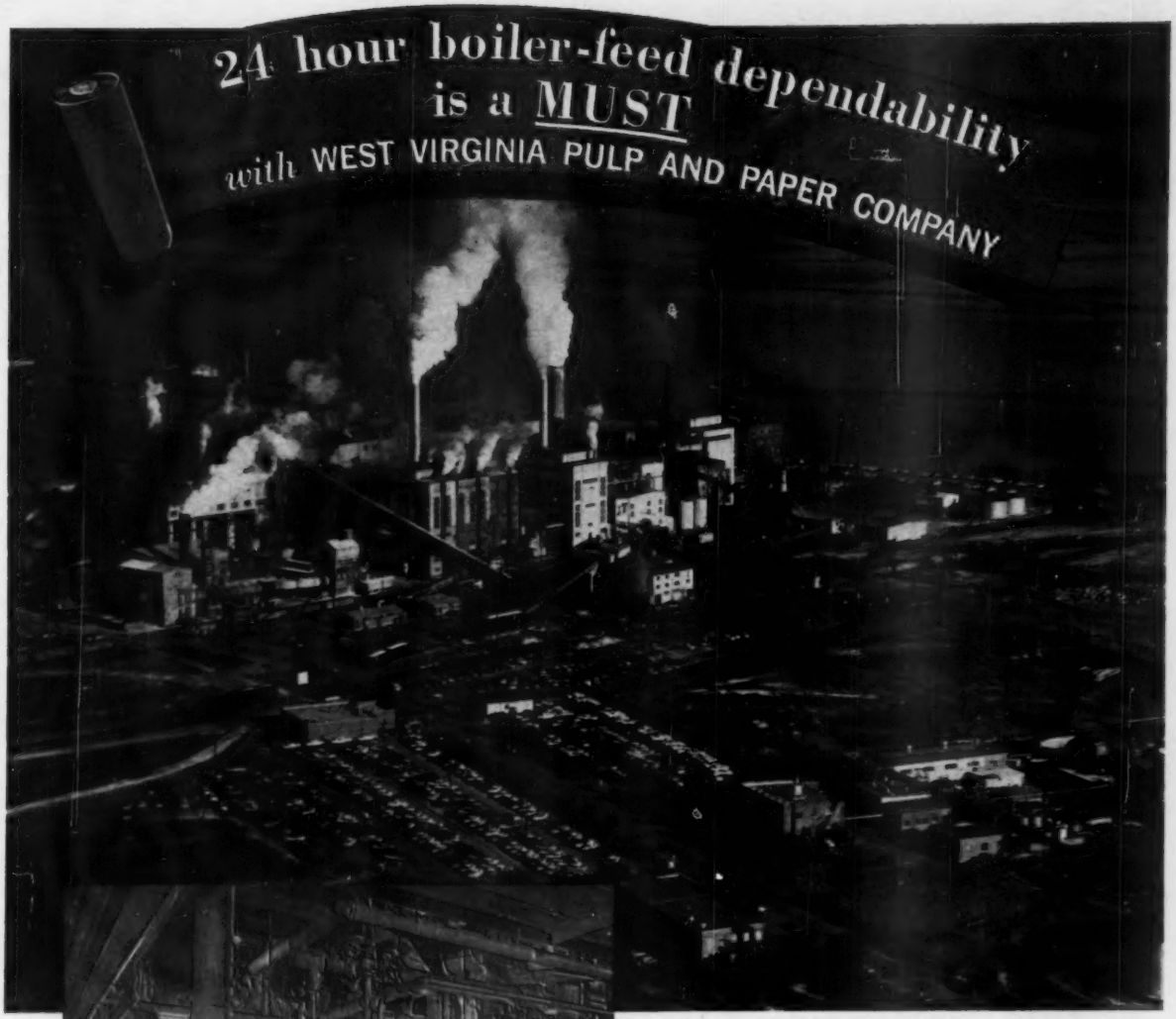
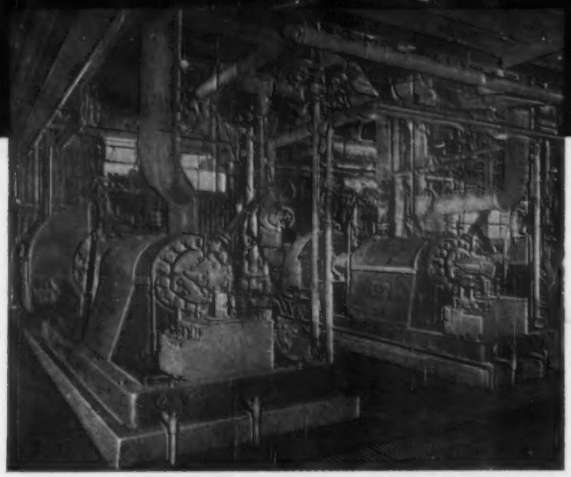
24 hour boiler-feed dependability is a MUST with WEST VIRGINIA PULP AND PAPER COMPANY





Pacific Type BFI pumps feed the latest boiler installation to help provide 1 million 620 thousand pounds of steam per hour required for 58,875 KVA power generation and plant process steam. A similar Pacific boiler feed installation is in 24-hour operation at the West Virginia Pulp and Paper Company plant at Luke, Maryland.

The Charleston, S.C. paper plant (illustrated above) is one of the largest producers of pulp and paper in the United States. The pulp mill processes 3 million 100 thousand pounds of unbleached sulphate pulp every 24 hours. The paper mill turns out 2 million 800 thousand pounds of linerboard, unbleached and extensible paper every 24 hours and several by-products.

Obviously, it takes a tremendous amount of power and steam to handle a job of this magnitude. The latest boiler installation at this plant is fed by three Pacific Type BFI 4", 10-stage pumps which are on the job, around-the-clock—*doing their part of the job.*

Pacific boiler feed pumps are second to none —in design, quality, performance, dependability, plus unparalleled parts and engineering service.

Write for Bulletin 122-A

PACIFIC PUMPS

Inc... A Division of Dresser Industries, Inc.

HUNTINGTON PARK, CALIFORNIA, U.S.A.

PACIFIC

CENTRIFUGAL PUMPS FOR PETROLEUM, CHEMICAL, UTILITY & GENERAL INDUSTRIES
OIL WELL PUMPS

BF-31

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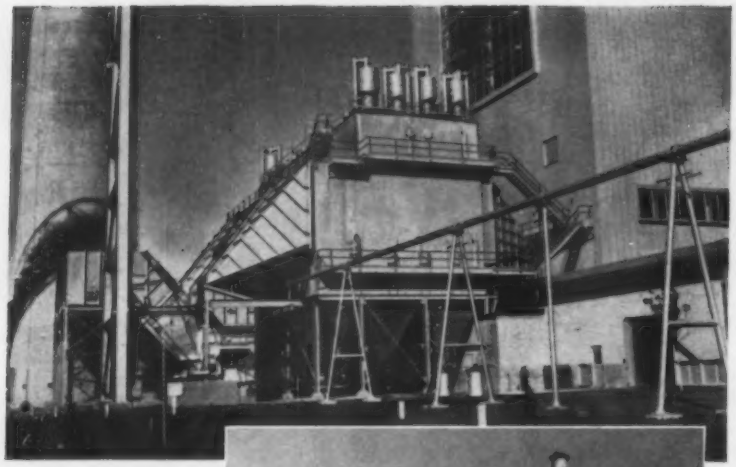

Research-Cottrell precipitator at a 150,000 KW generating station cleans over half a million cubic feet of gas per minute with 99% collection efficiency.

Con Edison's 350,000 KW generating station at Arthur Kill, Staten Island, has Research-Cottrell precipitators guaranteed to collect 99% of the fly ash from 1,400,000 cubic feet per minute of combustion gases.

Why These Plants Specify 99% Collection Efficiency

Industry's concerted efforts to solve the *air pollution* problem has resulted in an increased demand for 99% collection efficiency guarantees. Only through a continuing program of product improvement has Research-Cottrell made these 99% guarantees economically feasible. Efficient voltage application; specific control of electrical sections; opzel collecting plates; automatically controlled, fully adjustable electrode rapping for optimum operation; accurate internal baffling; proper gas flow patterns through three-dimensional model studies—these are a few of the reasons why Research-Cottrell has been able to increase collection efficiencies without increasing the size of the precipitator.

Research-Cottrell Extra Premium Experience and Know-How

Past performance and reliability are the two major barometers of experience and know-how.

These are the factors which have inspired confidence in Research-Cottrell products as exemplified in the most recent independent central station surveys made by Power and Electrical World magazines.

1960 SURVEYS of Typical Power Stations by both POWER and ELECTRICAL WORLD Magazines

	Research-Cottrell Equipment	
	Power	Electrical World
Percentage of Total Installations In Survey	36%	39%
Percentage of Total Precipitators In Survey	39%	35%
Percentage of Total Gas Cleaning Capacity In Survey	45%	42%

These surveys covered 47 modern central stations including over 75 electrostatic precipitators for air pollution control. In each survey, there were more Research-Cottrell installations reported than for any other of the half dozen manufacturers in the field.

Make sure you receive the "extra premium" which goes with every Research-Cottrell product—experience and know-how.

Research-Cottrell Personnel are capable of handling any problem in the field of gas cleaning and will gladly assist you with your application.

For more information on Research-Cottrell's program of product improvement, contact our local representative or write to the home office.

Research-Cottrell

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, New Jersey

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RC225

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Power Engineering

ATOMICS

308 EAST JAMES STREET
BARRINGTON, ILLINOIS

A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

May 1961

New Light on SL-1 Accident. Our preliminary report on the SL-1 accident in the March issue of ATOMICS was based on very meager information released immediately following the accident and led to erroneous implications concerning the safety of boiling-water reactors in general. In presenting the report in the March issue, it was assumed that SL-1 was operating when the explosion occurred. Actually it was not. The reactor had been shut down for 11 days, and the blast occurred while operators were re-installing the control rod mechanisms on top of the reactor.

This discloses the accident in an entirely different light. First, it completely exonerates the boiling-water principle as a contributing factor in the accident. Under the circumstances, a similar accident could have occurred had SL-1 been a pressurized reactor, or indeed any type of liquid-cooled reactor. Secondly, the design power capacity of the reactor in no way affected the extent of the nuclear excursion — it probably would not have been very different if SL-1 had been much larger. The important fact is that the reactor was shut down; therefore the inherent safety of the boiling-water reactor due to its negative temperature coefficient had no bearing on the SL-1 accident.

On January 27, the AEC's General Manager's Board of Investigation issued an interim report which provides much more information concerning the circumstances surrounding the accident and on the condition of the reactor both before and after the blast.

Summary of Findings. The interim report of the Board states specifically that the explosion involved a nuclear reaction. The thermal neutron velocity time above the reactor was estimated to have been approximately 10^{10} n/cm² (10 billion neutrons per sq cm). Chemical and radioactivity measurements made on a single fragment of reactor fuel ejected by the explosion, if representative of the total fuel, suggest that the reaction may have resulted in 1.5×10^{18} fissions. This would have produced 50 Megawatt-seconds of energy.

At the time of the explosion, the reactor crew appears to have been engaged in the reassembly of control-rod mechanisms and housings on top of the reactor. The pressure generated in the reactor, which may have reached several hundred pounds per square inch, was vented through a number of partially closed nozzles in the head of the reactor, blowing out shield plugs, portions of control rods, and some fuel. The explosive blast was generally upward from the ports in the top of the reactor. Structural damage to the building, principally projected from the nozzles, was slight. Damage to the reactor could not be determined at the time of the interim report.

Some gaseous fission products, including radioactive iodine, escaped to the atmosphere outside the building. Particulate matter, however, was largely confined to the building, with slight radioactivity in the immediate vicinity of the building.

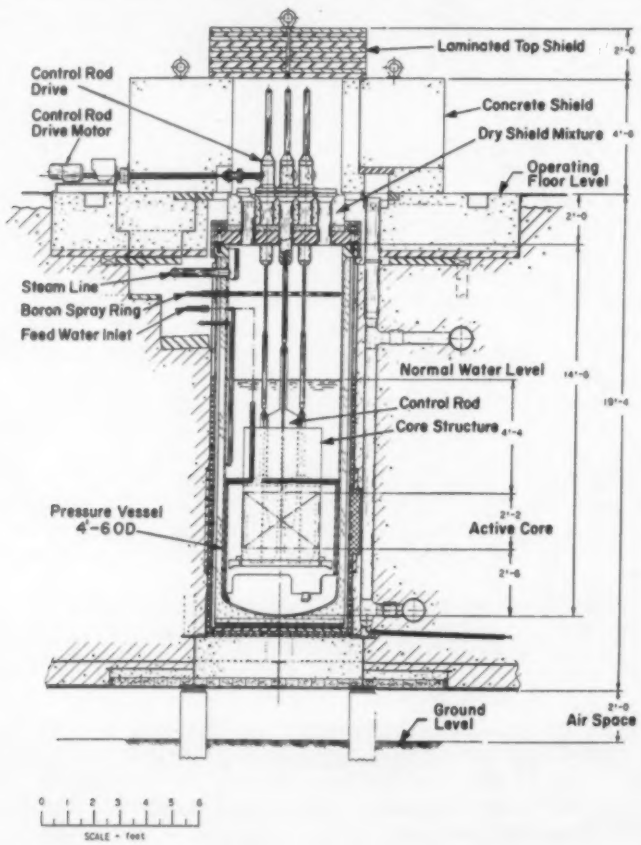
At the time of the interim report it was not possible to identify completely or with certainty the cause of the accident. The most likely immediate cause appears to have been a nuclear excursion resulting from motion of the central control rod. There was no evidence to support any of several other conceivable initiating mechanisms.

It was known that a variety of conditions had developed in the reactor, some having their origin in the design of the reactor and others in the cumulative effects of reactor operation, which may have contributed to the cause and to the extent of the accident.

SL-1 Shut Down on December 23. While the seriousness of the SL-1 accident should not be underestimated, it is reassuring to know that the reactor was shut down at the time of the blast. This precludes including any operating principle of water-cooled reactors among the possible causes of the accident.

After having been in operation for slightly more than two years, the SL-1 was shut down on December 23, 1960. It was planned that maintenance on certain components of the whole reactor system would be performed during the succeeding 12 days and that the reactor would again be brought to power on January 4, 1961. (The accident occurred on January 3.) Although maintenance work on several auxiliary systems of the plant was completed during this period, the only work planned for the reactor core was the insertion of 40 cobalt flux measuring assemblies into fuel element channels of one quadrant of the core. Access to the core through nozzles in the head of the reactor vessel required removal of the control-rod drive assemblies. This portion of the work was begun during the early morning hours of January 3. When the day crew (including personnel from the military and from Combustion Engineering) arrived at the SL-1 on January 3, dissembly had been completed. Installation of the flux measuring assemblies was completed during the day under the supervision of Combustion Engineering personnel.

The crew of the next shift (4:00 p.m. to midnight) consisted of the three military personnel who lost their lives, a chief operator, an operator, and a trainee. This crew and the one to follow were assigned the task of reassembling the control-rod drives and preparing the reactor for start-up. The general location of the control-rod drives as well as other components of the SL-1 reactor are shown in the accompanying sectional drawing.



Thus, it was during these reassembling operations that the accident occurred. The fact that SL-1 happened to be a boiling-water reactor, therefore, was not a contributing factor in the mishap; indeed, it is possible that the expulsion of water from the core terminated the nuclear excursion.

Possible Causes. From consideration of the factors which may have caused this accident, it is possible to conceive of several different items or combinations of items which may have constituted the immediate initiating event. The accident could have occurred with no errors on the part of the crew being committed, although certain errors on the part of the operators can also be visualized as possible initiating events.

It is known that the tasks assigned to the operators, that is, the reassembly of the control drives, involved the lifting of the control blade a maximum of 4 inches. Testimony before the Board indicated that the Chief Operator and the operator had performed this same task at least four times before the occasion in question and that they had been specifically trained for this job. Their training included the explicit instruction that under no conditions was the central control rod to be lifted more than four inches. From the positions of the men after the accident and the injuries they suffered, the Board was unable to rule out the possibility that one of them was engaged in lifting the control rod at the time of the blast. There was, however, no direct evidence concerning this possibility.

In the light of measurements made prior to the reactor shutdown on December 23, it would have been necessary to raise the central control rod a minimum of 16 inches at that time to produce criticality. On the basis of existing information on the reactivity worth of the central control rod (prior to shutdown) and the results of BORAX and SPERT experiments, it is estimated that this rod would need to have been drawn out another 6 or 8 inches at a rate of approximately 24 inches per second in order to produce a nuclear excursion in the magnitude estimated to have occurred. Although these actions and conditions appear credible, they do not appear probable in the light of the preliminary evidence thus far available.

Another set of circumstances that can be postulated involves the possibility that some changes occurred in the properties of the reactor between December 23 and January 3 — changes which would minimize the capability of the control rod system to maintain the reactor shutdown. There was no evidence at the time the interim report was made that any such changes took place. If loss of cadmium (the neutron absorbing material in the control rods) or loss of boron occurred during the shutdown period in question, the shutdown margin of reactivity would be reduced. With a reduced shutdown margin of reactivity, substantially less withdrawal of the central control rod would have produced criticality. Other conceivable initiating events, though their likelihood appears to be low, include: (a) A water-metal hydrogen explosion, or other chemical reaction, which would drive out the central rod or several rods from below or by a general pressure increase. (b) Addition of water to a core which had become dry and otherwise changed. The interim report emphasizes the fact that this discussion of conceivable causes is limited to possibilities and was not intended to imply any degree of responsibility. It appeared that the most likely cause involved some movement of the control rod.

There Had Been Difficulties. A variety of factors had developed in the reactor, some of them having their origin in the design of the reactor, and others in the cumulative effects of reactor operation, which may have contributed to the cause or extent of the accident.

The five cadmium control rods were cruciform in cross section. There was one central rod and four outer ones. Each blade of these structures consisted of a sheet of cadmium sandwiched between two plates of an aluminum envelope. An extension of each control rod projected through the top head of the reactor pressure vessel into a sealed housing containing the rack and pinion gear and the coiled spring shock absorber which absorbed the energy acquired by a control rod during the free fall of a scram.

Along one side, and sometimes on two sides, of each fuel element, a strip of aluminum-boron-nickel alloy was attached as a burnable poison. The strip was spot welded to the side plates of the fuel elements at 3-in. intervals. Early in the life of the reactor, it was noted that these strips were beginning to bow outward, away from the fuel plates in the sections between the attachment weld points. This bowing increased with time to a point where the central fuel elements could only be removed with great difficulty. Concurrently, the reactivity of the reactor began to increase more rapidly than expected. In September 1960 three fuel elements were removed for inspection, but great exertion was required to remove the elements from their positions in the core, and the boron strips remaining on the elements were damaged and shattered in the process. It was estimated that 18 per cent of the boron had been lost from the core. Later, in November 1960, six additional cadmium-boron strips were placed in the reactor and the shutdown margin increased by about 1 per cent, less than expected.

There had also been difficulties in the free movement of the control rods. Over the first year of operation, this difficulty arose from the friction in the seals through which the drive rod shafts penetrated the rack and pinion gear housings on top of the reactor. It was frequently found that one or another of the rods would not fall freely when the magnetic clutch drive was disconnected in a scram or single rod-drop test. Later the rod sticking problem, both on insertion and on withdrawal (when manual assistance to the motor drives was sometimes used), became accentuated. Evidence suggests that the control rod shrouds may have been compressed by the expanding boron strips so that rod movement within the shrouds was impeded. Over the last two months of operation, approximately 40 rod stickings were recorded in the Operations Log. During the last period of operation, the rods were assisted manually in their withdrawal, and on scram at shutdown, three rods had to be driven in by their motors.

Thus, a number of difficulties were experienced in the months preceding the accident, but since the reactor was shut down at the time of the mishap, it is unlikely that these difficulties contributed directly to the cause of the accident. The area around the reactor is still too radioactive to permit personnel to make inspection of the damage, but by the use of remote control motion picture and television cameras, it has been possible to determine the condition of the core and the top of the reactor. Six of the nine nozzles in the reactor vessel were shown to be open to the atmosphere. Cameras lowered through these openings indicate severe displacement of the core structure and damage to the fuel elements. Four of the control rods, however, are down in the core. There was also evidence of bubbles in the pictures which seems to indicate that there is still water in the core. Based on the damage to the cover plate, the assumption that the cap on nozzle 8 was blown off, and the fact that the damage was confined to a localized area above the core, it appears that water was expelled rather than steam. The mechanism of core shutdown is not known; possibly it was by expulsion of water. One reassuring aspect of the accident is the fact that even though the SL-1 building is not a containment shell, it appears that practically all the particulate fission products have been confined to the operating floor and to the immediate area surrounding the power plant building.

IMPORTANT NOTICE: As previously announced, ATOMICS, beginning in July, will be published as a full-fledged magazine, issued quarterly. Charter subscription rates will be: U.S. and Canada, $5 per year; foreign, $10 per year. As a SPECIAL INDUCEMENT to those subscribing now, we will send the current ATOMICS reprint (July-Dec 1960) free with a year's subscription to the new ATOMICS Quarterly. If you wish to take advantage of this offer, please fill in the form below and mail it to: Editor, ATOMICS, 308 E. James St, Barrington, Illinois

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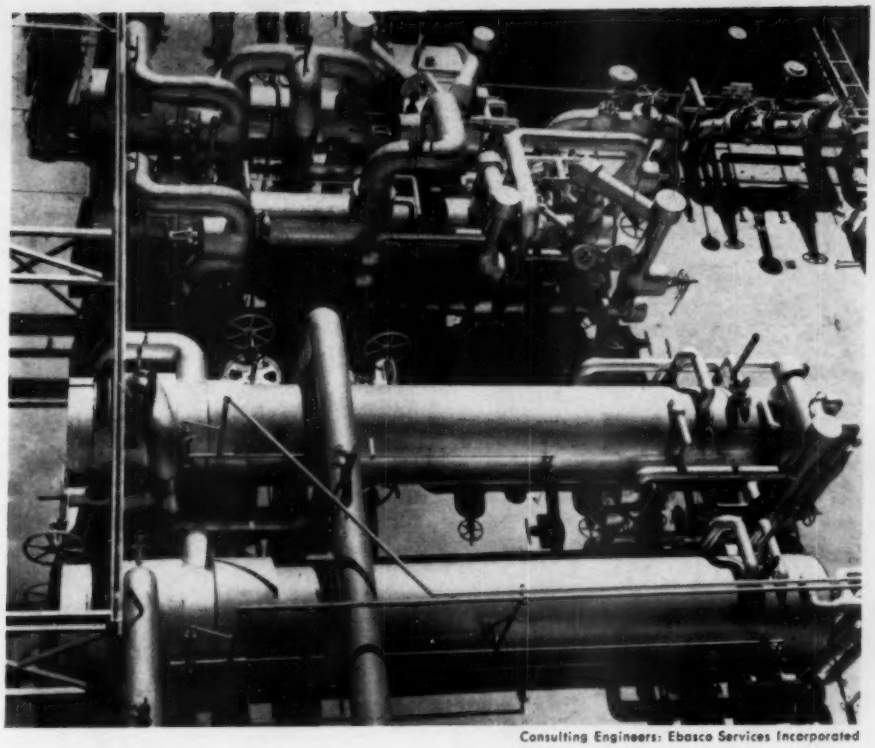

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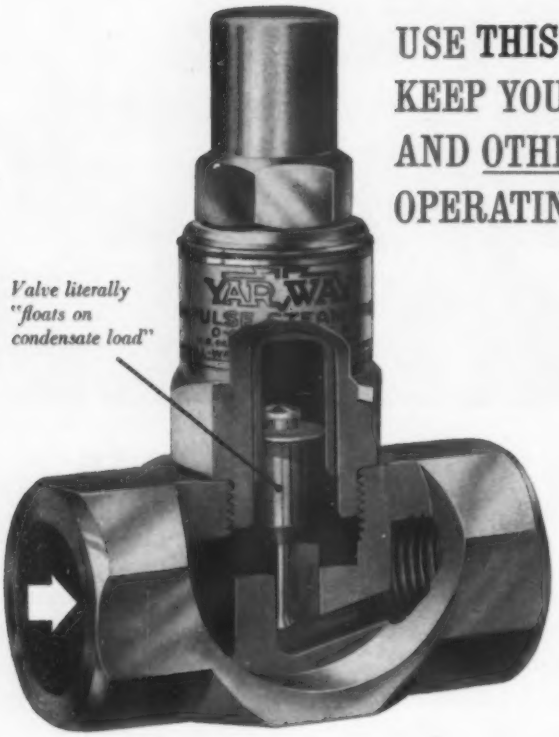

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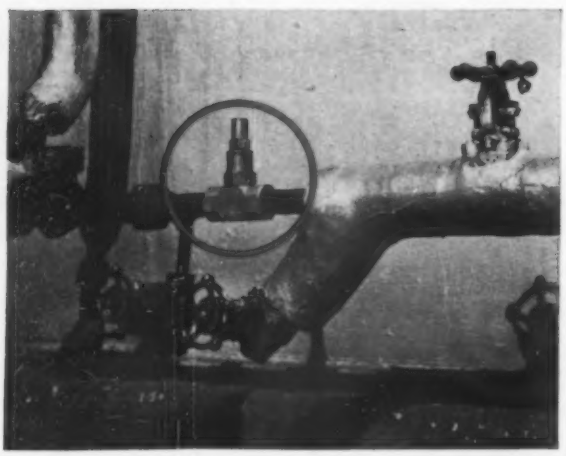

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POWER INDUSTRY'S LEADERS EXCHANGE INFORMATION AT AMERICAN POWER CONFERENCE

TOP POWER ENGINEERS, from utilities and industry, met at Chicago recently to compare notes on latest developments in the power field. Despite curtailment in company travel budgets, the meeting was well attended by some of the top names in the business.

Conference was officially opened by William F. Crawford, president of Edward Valves, whose theme was "Our Changing Perspectives." Mr. Crawford voiced the sentiments of hundreds of men in our field when he urged that allowances be provided for more research, and that product purchasers agree to assume some of the research cost burden. He also stated that "business requires total competition that combines good products, and good management, with good profits."

At the opening day's luncheon, the guest speaker, Sherman R. Knapp, pres. of E.E.I. and Connecticut Light and Power, gave a very entertaining talk which held both laughs and food for serious thought. Mr. Knapp expressed the serious concern of utilities in future manpower problems, due to competition from the glamour fields, such as rockets and missiles.

Mr. Knapp covered many topics of concern to utilities, such as: government in power, future of fossil-fuel generation, development of more off-peak uses of electricity, and unconventional power sources. It was certainly a most interesting and entertaining talk.

Transmission, Distribution

In the electric transmission and distribution category, excellent papers covered such varied subjects as radio noise, EHV wood-pole lines, switching, transformers and underground distribution.

R. J. Mathew and E. H. Gehrig of Bonneville Power Administration told of investigations on their EHV lines — in control of radio noise. Their conclusions show that conductor surface smoothness, and diameter, are greatest determining factors in radio interference from transmission lines.

Line switching surges were discussed in a paper by Johnson, Silva and Wilson, all of General Electric. This dealt with EHV lines, both in energization and reclosing after a fault. *Dead-time*, end-loading and arresters all influence these surges, they concluded.

Speaking of underground distribution, R. F. Lawrence and R. B. Pherson (both of Westinghouse) discussed latest developments in this field. Interesting methods, equipment and cost studies were discussed.

K. S. Field of Ebasco gave a very good discussion on distribution construction equipment and practices. He cited the need for ever-increasing research needed in the field of cost reduction through more efficient equipment.

Having had excellent experience with wood-pole lines (for 138 kv), the Illinois Power Co feels that equal success can be attained on 345-kv lines for future construction. A paper by T. W. Schroeder (I.P. Co) and J. E. O'Neil (Westinghouse) presented some most interesting details of this line-design investigation.

John J. Mikos, S. and C. Electric Co, authored a most interesting paper on a "hybrid" solution to lower cost in sub-transmission switching. He stated that, with proper analysis of circuit conditions, a combination device known as a "Circuit-Switcher interrupting unit" could substantially reduce the total cost of switching protection on lower voltage transmission circuits.

Electronic control, plus a shaded-pole motor, has led to more reliable self-regulating distribution transformers, according to D. A. Manning of Line Materials Industries. This development will tend to affect design of future distribution systems now that field tests have shown its reliability.

Computers and System Planning occupied a considerable portion of the program. Experiences and latest developments were described.

Nuclear Power Development

Various aspects of nuclear power development were considered at several of the technical sessions and luncheon meetings. Of particular interest was the Evening Forum on "Future Sources of Electric Power," because all of the papers presented at this session dealt with applications of nuclear energy.

At this session Dr. Stirling A. Colgate of the Lawrence Radiation Laboratory, University of California, outlined the latest developments in thermonuclear power research. The attainment of a controlled thermonuclear power plant, Dr. Colgate said, was closer than it used to be.

Reviewing the history of thermonuclear research, the speaker pointed out that the early optimism had given way to a sneaking suspicion that perhaps machines to make hot plasma were not going to be exactly simple or easy. All early experiments were troubled by instabilities which seemed almost impossible to control. However, by the time of the second Geneva Conference in September, 1958, it had been established that a plasma of 20-kev electron temperature had been held for a few milliseconds, which represented almost a million times the single escape particle time.

From that time on, a number of important discoveries were made; the stellarator work made steady progress, the Astron principle showed merit, the DC-X experiments at Oak Ridge provided a new approach. R. F. Post's cusped geometries shed new light on the problem, and last summer and early fall the first two stages of trapping, transfer, and initial compression were achieved and diagnosed.

These measurements resulted in documenting a thermal plasma of a few $\times 10^{13}$ particles/cc at 2.5-kev temperature, lasting for a time limited by the resistance of the coils. With these numbers in hand it was evident that a thermonuclear reac-

Sherman Knapp, president of E.E.I. and Connecticut Light and Power, addresses a joint APC-ASME luncheon

tion should be taking place, and this was soon confirmed. For the first time a quiescently-contained plasma had demonstrated a thermonuclear reaction. The time-scale to feasibility, said Dr. Colgate, had taken another drop.

A second paper at the Evening Forum also dealt with thermonuclear research. This was a paper entitled "Engineering Frontiers of Thermonuclear Power" by C. W. Little, Director of Operations, C-Stellarator Associates, Princeton University. The C-Stellarator has been under construction for several years and is now virtually complete. This is by far the largest experimental device for high-temperature plasma research in existence, and its performance later this year will be awaited with great interest. Dr. Little described the essential details of the machine and showed late photographs of this $30 million facility.

The third paper at the Evening Forum, by Dr. R. E. Henderson, Chief Applied Physicist, Allison Div, General Motors Corp, was devoted to a general discussion of "Nuclear Fuel Cells." A nuclear fuel cell, as explained by Dr. Henderson, is similar to a conventional fuel cell in that it uses chemical reactants to produce electricity directly from chemical reactions; but in the nuclear fuel cell the reactants are continuously regenerated by means of nuclear energy.

Such cells, however, are only in the earliest stages of development, and many problems remain to be solved before practicable units are developed. Since the main features of the fuel cell are its potential simplicity and reliability, Dr. Henderson indicated that the first applications for these cells will fall in areas where reliability is at a premium; for example, in space technology.

The session on Nuclear Power Plants was featured by three papers; the first was on the "Present Status and Future Promise of Gas-Cooled Reactors" by Peter Fortesque, Titus G. Le Clair, and Corwin L. Rickard of General Atomics.

This paper briefly covered the history of gas-cooled reactors in England. It described in some detail the 40,000-kw prototype High-Temperature Gas-cooled Reactor (HTGR), being designed to demonstrate (in a commercial-sized plant) those features that, in a large system, are believed to be necessary for the attainment of economical power through the effective use of modern steam conditions.

This plant will produce steam at 1450 psi and 1000 F. It is expected that this prototype will lead to the construction of a 300-Mw plant, with fuel costs in the range of 1.2 to 1.7 mills per kwh, and an over-all power cost that will enable it to compete with power from coal in many areas of the United States.

A paper by Dr. R. B. Richards of General Electric's Atomic Power Equipment Dept discussed the technical and economic aspects of central station boiling-water reactors. Large-scale boiling-water nuclear power plants, said Dr. Richards, can now be built to compete with fossil-fueled power plants in some areas of the country. A standard 500,000-kw dual-cycle boiling-water reactor plant, he said, can be built using today's technology for start-up in 1965 at a cost of $175 per installed kilowatt under favorable site conditions.

This view of nuclear power development was essentially the same as that presented by J. W. Simpson, vice-president of Westinghouse Atomic Power Division, in his paper on the technical and economic status of central station closed-cycle water reactors. From an analysis of recent studies, Mr. Simpson said that his company felt that we are on the threshold of economic power in the higher fuel-cost areas. It was his belief, however, that we have only scratched the surface of potential for improvement.

This confidence in the future of economic nuclear power was again stated by Titus G. Le Clair of General Atomics in his address at the luncheon on the last day of the Conference. He reported that nuclear power plants scheduled to come into operation in 1963–1964 are expected to produce electricity for about 8 mills per kwh, or close to current power costs in some fuel-scarce areas of the United States.

Subsequent large-scale plants, on the order of 300,000 kw capacity, now being designed, and taking advantage of advanced technology, Mr. Le Clair said, can be expected to bring the costs of atomic power still lower. He summarized results of a recent survey which he made among nearly 40 utility leaders, manufacturers, and nuclear scientists, on the economic prospects of nuclear power. The results reflected a belief that, over the next ten years, the cost of fossil fuels will go up 12.9 per cent, while the cost of nuclear fuel will drop 9.4 per cent. In 1970, Mr. Le Clair said, nuclear plants may account for 10 per cent of that year's new capacity, and in 1980 for 25 per cent.

Central Stations

Cleveland Electric Illuminating Co related the first year's operating experience with the 250,000-kw supercritical-pressure generating unit at the Avon Lake Plant. The paper gives the impression that the company is not very happy with its first supercritical unit. However, this may be partly due to the avowed purpose of dwelling on the troubles experienced, rather than on how well the equipment works.

Comments such as the following are indicative of the general tone of the paper: "The first-year availability record of this supercritical-pressure unit is not too discouraging. However, the long-term reliability of the supercritical design remains to be proven."

Poor thermal performance is blamed largely on the full peripheral steam entrance, and on the minimum economical load corresponding to the 30 per cent by-pass flow limitation of the boiler. Development of a new material, called Nivco, for the first row blades will permit two-step sequencing of the admission valves, and it is hoped that additional experience will establish the feasibility of operating with lesser flows. It does not appear economic to reblade the first row at this time, but it may be done within the next few years.

In conclusion, it is agreed that the supercritical-pressure unit is a tech-

nical success, but the point is made that this does not insure economic success. It is evidently believed that the better thermal performance to be expected from the supercritical unit does not justify the present capital cost difference over the subcritical unit in the size range of 250,000 kilowatts.

Westinghouse and Combustion Engineering described operation of the turbine generator and steam generator, respectively, at Avon and established the over-all satisfactory design of the individual units.

Philip Sporn and engineers of the American Electric Power Service Corp gave a rather glowing report on the 500-Mw supercritical-pressure Breed Plant. This was in marked contrast to the description of the Avon Plant. Many problems naturally arose, but the impression is given that all were handled satisfactorily.

Work is being done on the further development of the supercritical-pressure cycle, exploiting larger units, and with initial and reheat temperatures going up on an ascending scale instead of down on a descending scale.

Paradise Plant

Engineers of the Tennessee Valley Authority described the Paradise Plant, which is now under construction. Operation of the first 650-Mw unit is scheduled for September, 1962, to be followed by a second unit of equal capacity in July, 1963. Station layout will accommodate two additional units of equal or greater capacity.

Each generator of the cross-compound unit is rated 325,000 kw at 0.9 pf and 32-psi hydrogen pressure. The stator winding is direct-cooled by water. Seven outgoing 161-kv transmission lines feed into the TVA system.

Turbine is a 3600/1800 rpm 4-flow unit designed for initial steam conditions of 2400 psig, 1050 F with reheat to 1000 F, and with eight stages of feedwater heating. Expected continuous capability at 1½ in. Hg back-pressure and zero per cent makeup is 700,000 kw. With the top feedwater heater by-passed, a short-term peaking capacity of 740,000 kw is expected.

Steam generator is a single pressurized furnace with two division walls, cyclone fired, slag-tap type, of the once-through design principle. Rated continuous outlet capacity is 4,900,000 lb per hr at 2450 psig, 1053 F, and reheater steam flow of 3,480,000 lb/hr at 474.5 psig, 1003 F.

Estimated net plant heat rate is 7775 Btu per kwh, with 4 per cent auxiliary power, zero makeup, 1½ in. Hg back-pressure, and generator output of 700,334 kw.

Controls will include stored-program data processing-computing equipment by use of a general purpose digital computer. Memory capacity and other features will be incorporated which will provide, or be expandable to provide, for calculating performance data and a nominal amount of monitoring start-up and shutdown sequence. It will also be capable of further expansion as required for further monitoring and automatic control.

Bulk of the coal used for some time will be mined in the immediate vicinity of the plant and will be hauled to the plant over private roads. As necessary in the future, other facilities for fuel transportation can be provided.

Quite possibly this will be the biggest conventional type subcritical unit that will ever be built.

Relative merits of cooling tower or cooling pond were discussed by W. R. Steur of Sargent & Lundy. Both systems evidently have their own advantages; but probably of more interest is the general conclusion that with a very small spread in fuel cost, the production cost of the plant with a cooling tower or pond can be quite comparable to that of the conventionally cooled plant. When the artificially cooled plant can be located adjacent to a coal mine, then it can have a very definite cost advantage.

Combined Cycle

H. J. Petersen of United Engineers & Constructors, Inc, and J. O. Stephens of Westinghouse presented the results of a study made of comparative capital and energy costs of a conventional plant, and of a combination gas turbine-steam cycle.

Assumed steam conditions are 2400 psig, 1000/1000 F, and total net output for each plant is 678,500 kw. For the combined cycle, the gas turbine output is 78,700 kw.

Net plant heat rates are 8962 Btu per kwh for the conventional plant and 8666 Btu per kwh for the combined plant.

For an assumed typical case wherein cost of both coal and gas is thirty cents per MMBtu, annual operating savings of the combined cycle over the conventional cycle is $558,000. Plant capital costs are essentially the same for both cycles. Under these conditions, the cost of energy for the combined cycle is less than 6 mills per kwh.

William F. Crawford, president of Edward Valves, addresses the opening session of the Conference

Binary Cycle

A very interesting discussion of the Binary Cycle for Power Generation was submitted by David Aronson of Worthington Corp. Use of a thermal fluid in the low-temperature end of the cycle results in significant reduction in volumes of low-temperature working fluid and improvement of the heat rate.

Only water-cooled systems are treated in the paper, but it is pointed out that the binary cycle is particularly advantageous in plants that must use air cooling because of scarcity of cooling water. The comparatively small specific volume of refrigerant working fluid gives promise of economic operation with condensing temperatures as low as 40 F, or for air-cooled systems as low as minus 10 F.

Written discussion of this paper was presented by Carl D. Shields of Wilmington, Del., who claims that it is possible to achieve:

1. A 6500-Btu/kwh net plant heat rate with a 2250 psi, 600 F simple single-fluid power cycle.
2. A 5000-Btu/kwh net plant heat rate with a binary-vapor cycle of the type described by Mr. Aronson.

Mr. Shields makes the very challenging prediction that the turbine-driving medium of the future will be a thermal fluid other than steam. He also foresees the probability that smaller plants with high efficiency

will reverse the trend toward largeness.

Philadelphia Electric Co and Westinghouse Steam Division collaborated on a description of one of the first power plant flash evaporators to be installed. Put into service and tested during 1960, the unit has realized its predicted high economy, production, and purity requirements. Largest generating unit served by the flash evaporator is 180 Mw, 1250 psig, 950 F, which was added to the Richmond Steam Generating plant in 1950.

Boiler Feed Pumps

Igor J. Karassik of Worthington Corporation presented the Second Progress Report on High-Speed Boiler Feed Pumps. His definition of this designation is a pump operating generally above 3600 rpm and developing heads of 1500 feet or more per stage. Mr. Karassik believes that the growing pains of this type of pump are over. He predicts that by 1965 more than 50 per cent of all high-pressure boiler feed pump orders will be for high speed pumps. By 1970 the 3600-rpm design should be relegated to join its 1800-rpm ancestor.

Richard D. O'Neil of American-Standard submitted a paper on Developments and Operation of Fluid Drives for Turbine-Generator-Driven Boiler Feed Pumps. He points out the flexibility for use of shaft-driven pumps regardless of design of turbine generator, size of pumps and other factors. A recent development is placement of the pump and its drive on the turbine end rather than on the generator end. Studies indicate considerable savings in placing the pump on the turbine shaft.

Electrical Apparatus

Of special interest at the Electrical Apparatus session was the paper "Harmonic Excitation of Synchronous Machines" by F. I. Biggs and P. I. Nippes, both of Elliott Co. This system is based on the use of the odd harmonics contained in the generated voltage wave of all commercial synchronous machines. All these harmonic voltages present in a single phase can do useful work, but as practically all alternating current is generated as 3-phase power, the triplen (that is, the third and odd multiples thereof) harmonic voltages, since they are in phase with each other in all phases, will cause no triplen current to flow between phases in the external circuit and consequently do no useful work unless a 4-wire system is used.

If a portion of these triplen harmonics in the flux wave can be converted into useful power in a separate stator winding, then this power is gained without any additional excitation requirement of the main generator field. This is the concept upon which harmonic excitation is based. The installation of a 25,600-kva turbine generator with this harmonic excitation system is expected to be completed early this summer.

Another excellent paper at the Electrical Apparatus session was one by Leonard Reid of Allis-Chalmers. This explained the "Why and How of Auto-transformers." Although the auto-transformer is not new, its importance is increasing daily. Its low cost, high efficiency, small size, and low impedance make it of particular importance in the development of new suburban electrical systems.

The question of thermal upgrading of transformers was discussed in a paper by J. R. Meador and J. H. Carpenter of the Pittsfield, Mass., and Rome, Ga., works of General Electric Co. The authors of this paper feel that because of improved methods of rating insulating materials, the average temperature of transformer windings can be raised from the present 55 degree C maximum to 65 degrees, without decreasing the life or jeopardizing the integrity of the transformer.

Automation and Control

Automatic control in modern steam power plants has reached a high degree of sophistication. This was well reflected in the various papers presented at the session on Automation and Control. The first two papers at this session considered two aspects of automation, one by L. K. Kirchmayer and H. J. Fiedler of General Electric on the "Automation of System Operation," and the other by B. L. Lloyd, J. W. Skooglund, and D. M. Sauter of Westinghouse on "Automatic Power Plants."

Automation of system operation is relatively new, whereas the development of automatic control in power stations has resulted from continuous and orderly extensions in plant apparatus design and in plant control technology. In the past few years, however, control technology and control hardware have taken major steps forward with the development of the high-speed solid state digital control computer.

A total of nine control computers have already been purchased by utilities for automation of steam power plants in this country. Most of the remaining companies who purchase units of 100 Mw or more are now either performing or are preparing to undertake studies as to whether control computers should be applied to their next units, and if so, to what extent.

Another aspect of the situation was the application of automatic controls to an existing power plant. This problem was considered in a paper, "The Installation of Automatic Controls in an Existing Power Plant For Minimum Down Time," by J. A. Reich, T. H. Bloodworth, and L. M. Wilson, all of Allis-Chalmers. They pointed out that the installation of automatic controls in an existing plant will require modifications to both basic and auxiliary equipment and to existing instrumentation and controls. An example of this type of automatic control application was described in another paper at this session by M. J. Feldmann and J. W. Purssell, Jr, both of Boston Edison Co.

Fuels

H. M. Rayner of Western Electric Co and P. Seibold of Riley Stoker Corp described a series of tests to determine the minimum coal fineness that a boiler equipped with a turbo-furnace could burn without a reduction in efficiency. Results have shown that the boiler is able to satisfactorily burn coal with a size consist of 50 per cent through 200 mesh, and does it with no decrease in boiler efficiency.

R. A. Glenn and R. D. Harris of Bituminous Coal Research focused attention on the problem of sulfur in bituminous coal — especially pyritic sulfur — and what is being done to develop new methods for its removal from steam coals. They reported that where the pyritic sulfur is mainly associated with mineral matter, there are good prospects of its removal by adapting presently available equipment. Removal of the pyritic grains that are embedded in the organic matter will require the development of improved equipment for processing coal in the minus 200 mesh size.

How coal properties relate to corrosion of high-temperature boiler surfaces was discussed by J. T. Reese and James Jonakin of Combustion Engineering, Inc, and J. G. Koopman of Electric Energy, Inc. They pointed out that initial formation of deposits is due to selective deposition of low melting products

Continued on page 82

THE THERMIONIC ENERGY CONVERTER —A PROMISING HEAT ENGINE

B. S. LEO, OF DOUGLAS AIRCRAFT IN SANTA MONICA, CAL.,
DISCUSSES THIS CHALLENGING NEW POWER DEVICE

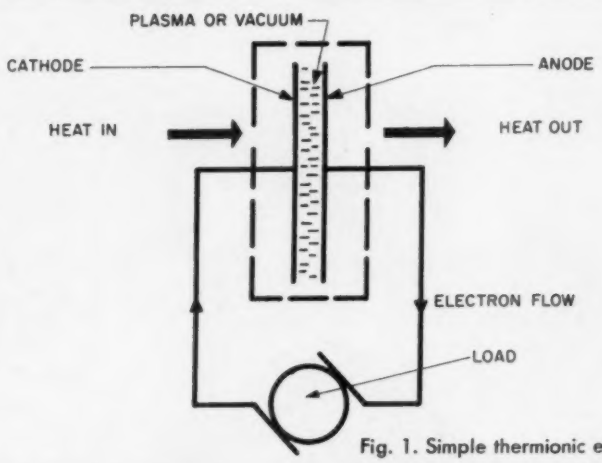


Fig. 1. Simple thermionic energy converter

THE WORKING PRINCIPLE of this power element is not unique; it is the same principle upon which our regular power plants work. Heat is added to the element at a high temperature, a certain amount of this energy is converted into electrical energy by causing electrons to flow in an electric circuit, and a certain amount of the heat added is rejected at a low temperature. However, the conversion of thermal energy into electrical energy by the thermionic converter is accomplished without any moving parts.

In its simplest form the thermionic energy converter consists of two flat plate metal electrodes of different material, the cathode and anode, enclosed in a vacuum or a plasma. The electrodes are connected to each other by a lead wire and external load, Fig. 1.

The Free Electrons

To explain the electron flow in Fig. 1, let us first consider the electrodes. The structure of the electrodes consists of atoms vibrating about their equilibrium positions and arranged in a certain geometrical pattern. Each atom consists of a positively charged nucleus and a limited number of negatively charged electrons which move in orbits around the nucleus. The number of orbits around the nucleus and the number of electrons in each orbit depend on the type of atom and vary from one metal to another. Due to the positive charge of the nucleus and the negative charge of the electrons, an attraction force exists between the nucleus and the electrons.

The electrons moving in orbits that are close to the nucleus are more firmly bound to the nucleus than the electrons moving in the outer orbits. Hence, the force between the nucleus and an electron in the outermost orbit is small and this electron can therefore move around quite freely. It may become equidistant between its own nucleus and an adjacent nucleus and may then leave its own orbit to travel and enter another orbit around some other nucleus. Thus, the electrons in the outermost orbits of the atoms can move around randomly and do not belong to any specific atom. These electrons are the free electrons of the electrodes. In loosing the electrons in the outermost orbit, the atom becomes positively charged and each electrode consists therefore of a lattice of positive atoms or ions submerged in a sea of free electrons, Fig. 2.

If the electrons were at the temperature of absolute zero, the kinetic energy of the free electrons would range from zero up to a certain maximum value called the Fermi value. The kinetic energy can be distributed in to certain fixed energy levels, which differ from one another by a very small but finite amount. Thus, the kinetic energy of the free electrons can be represented by horizontal lines in an energy level diagram, each line representing a certain kinetic energy, Fig. 3.

Each kinetic energy level contains a limited number of free electrons, just as each electron orbit surrounding the atomic nuclei contains limited numbers of electrons. The energy level can be empty, partly, or completely filled in the same way that the electron orbit can be empty, partly or completely filled. At the temperature of absolute zero, the energy levels are filled as far up as is necessary to accommodate all the free electrons; and the corresponding maximum energy level is the Fermi level.

One may think of the free electrons as stored on hypothetical shelves with respect to kinetic energy, the ones with the low energy being on the bottom shelves and the ones with the high energy being on the top shelves. The top shelf cor-

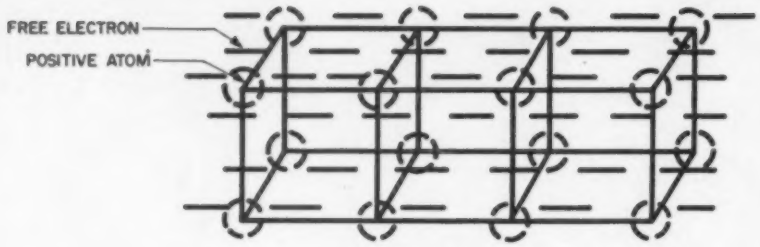


Fig. 2. Lattice structure of the electrodes

responds to the Fermi level, and its electrons have the highest energy of the free electrons. At high temperatures, only a small amount of the total free electrons occupy energy levels that are higher than the maximum energy level at the temperature of absolute zero. Hence, the energy level diagram at an elevated temperature is similar to the corresponding diagram at the temperature of absolute zero.

The electrodes in the thermionic energy converter have different Fermi levels; the cathode has a low Fermi level and the anode has a high Fermi level. If a free electron with an energy corresponding to the cathode Fermi level is to leave the cathode body and come to rest outside the cathode surface, it will require a larger additional amount of energy than the corresponding free electron in the anode if it were to leave the anode body and come to rest outside the anode surface. Thus, the free electrons in the anode Fermi level have more energy than the free electrons in the cathode Fermi level.

The energy that has to be supplied to a free electron in the cathode Fermi level, to make it leave the cathode body and come to rest just outside the cathode surface, is called the work function of the cathode. The corresponding amount of energy that is necessary to make a free electron in the anode Fermi level escape from the anode body and come to rest just outside the anode surface is called the anode work function.

Electron Flow

When sufficient heat is supplied from a high temperature source to the cathode, its high-energy free electrons in the Fermi level will attain enough energy to escape from the cathode body and surface. That is, they have gained an amount of energy equal to the work function of the cathode plus kinetic energy. If the electrons pass the interelectrode gap between cathode and anode without loosing any energy, the energy lost will be the kinetic energy of the electrons when they strike the anode surface and the energy corresponding to the anode work function, since it takes an amount of energy equal to the anode work function to get an electron in through the anode surface. The energy lost is rejected as heat from the low temperature anode.

Since the cathode work function is larger than the anode work function, there is a net amount of energy available for doing work, once the electrons have entered the anode and joined the high energy free electrons in the anode Fermi level. Thus, by connecting the cathode and anode with each other by means of a lead wire and load, power is produced by the thermionic energy converter when the electrons flow from cathode, through the interelectrode gap, to the anode, and back to the cathode through lead wire and load. The energy diagram for this ideal thermionic energy converter is shown in Fig. 4.

Efficiency

The efficiency of the converter is defined as the power developed across the load divided by the total heat input. It is assumed that there are no losses in the interelectrode gaps between cathode and anode and that anode temperature is low enough to prohibit any electron flow from anode to cathode through the interelectrode gap.

The work output from the converter equals the cathode work function minus the anode work function and the loss in the lead wire. The total heat input is the sum of the cathode work function, the kinetic energy of the electron and the losses, which consist of the radiation loss between cathode and anode and the heat conduction loss along the lead wire. Hence,

$$\eta = \frac{\phi_c - \phi_a - \phi_l}{\phi_c + 2kT_c + P_{loss}} = \frac{J(V_c - V_a - V_l)}{J\left(V_c + \frac{2kT_c}{e} + P_{loss}\right)} \quad (1)$$

The energy of the electron entering the cathode from the lead wire is neglected in this equation, since this energy is much smaller than $\phi_c + 2kT_c$. The energy loss due to gaseous conduction, if a plasma is present in the interelectrode gap, has also been neglected in equation (1), since the heat lost from cathode to anode by conduction through the plasma is small with respect to the heat lost by radiation from cathode to anode. The radiative heat transfer is

$$P_r = A_r\sigma\epsilon(T_c^4 - T_a^4) \quad (2)$$

Dividing equation (1) by the electron-emitting area of the cathode results in

$$\eta = \frac{J_c(V_c - V_a - V_l)}{J_c\left(V_c + \frac{2kT_c}{e}\right) + \frac{A_r}{A_e}\sigma\epsilon(T_c^4 - T_a^4) + \frac{\phi_l}{A_e}} \quad (3)$$

It is seen from equation (3) that the radiation loss per unit area of cathode-electron-emitting area can be made small by making A_e large with respect to A_r.

The saturation current, J_c, is calculated from the Richardson-Dushman equation,

$$J_c = AT_c^2 \exp(-\phi_c/kT_c) \quad (4)$$

The cathode lead wire has to have an optimum cross-sectional area in

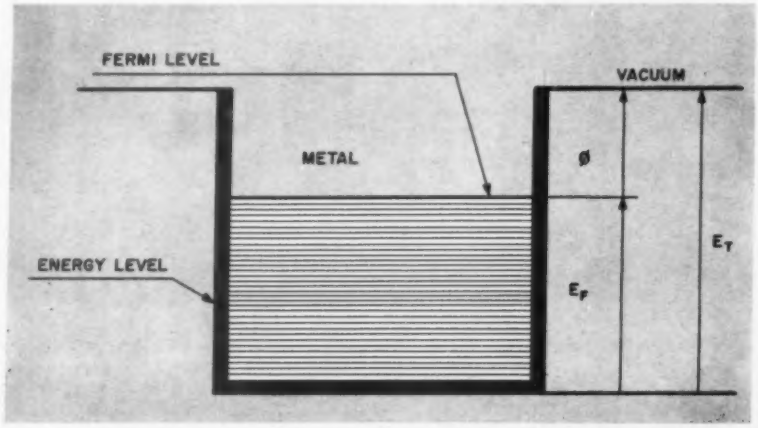


Fig. 3. Energy diagram. E_a is the energy difference between an electron at rest inside the metal and one just outside the metal surface. At the temperature of absolute zero, all energy levels up to E_f are filled. The work function $\phi = E_a - E_f$

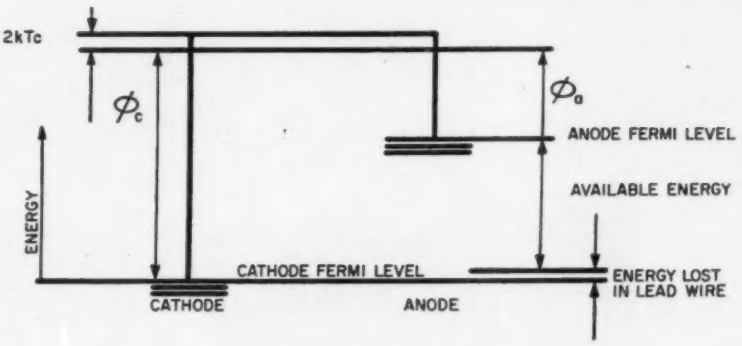


Fig. 4. Energy diagram of an ideal thermionic converter

order to obtain maximum efficiency from the thermionic energy converter, since a low ohmic power consumption in the lead corresponds to a relatively high heat loss due to conduction in the lead. By optimizing the efficiency with respect to the resistance of the lead wire, the optimum cross-sectional area of the cathode lead wire is,

$$A_l = J_e A_e L \left(\frac{\rho}{\eta K (T_e - T_a)}\right)^{1/2} \left(1 - \frac{\eta}{2}\right)^{1/2} \quad (5)$$

The resistance of the cathode lead wire is,

$$R_l = \frac{\rho \times L}{A_l} \quad (6)$$

Practical Converters

The thermionic energy converters that have been tested most extensively up to now are the close-spaced and plasma-type converters. In the close-spaced converter, the distance between cathode and anode is very small, less than 0.0004 of an inch, in order to reduce the potential barrier or space charge in the interelectrode gap, which is due to the electron flow between cathode and anode and which has to be overcome by electrons leaving the cathode surface.

The plasma-type converter has a larger interelectrode gap and the space charge is here reduced by the positive ions in the plasma. The plasma is produced by introducing a vapor in the interelectrode gap that will produce positive ions when contacting the hot cathode surface. The atoms of the vapor may also be ionized upon collision with the high energy electrons leaving the cathode. It is not known which method produces the greatest amount of ions, since more research is required in this area to make accurate calculations possible.

The efficiency of these converters is about 7 per cent of the close-spaced type and 10 to 12 per cent for the plasma type. Attempts have been made to increase the efficiency by making the cathode emitting area large with respect to its radiating area by constructing the cathode as a cavity-type emitter. Its thermal radiation is then approaching that of a black body. Some gain in efficiency has been achieved by this method, but difficulties have been encountered in obtaining a satisfactory electron flow from cathode to anode, and more research is needed to overcome these difficulties of this particular design.

The thermionic energy converter can also be designed in the form of two concentric cylinders, the inner cylinder being the cathode and the outer cylinder the anode. This design is suitable for use in a nuclear reactor since the fuel rod elements can be arranged to heat the cathode directly.

Materials that are suitable for the cathode in the thermionic energy converter are tungsten, barium-impregnated tungsten, molybdenum and tantalum. Silver oxide, tungsten oxide, and copper are suitable anode materials. Vapors that can be used to reduce the space charge in the plasma converter are cesium, rubidium, and potassium. The most frequently used is cesium, which not only reduces the space charge but also decreases the work function of the cathode and anode when adsorbed on their surfaces. This effect plays a major part in the efficiency of the plasma-type converter, since a partly covered cathode is a good electron emitter and a covered anode rejects less heat, thus increasing the efficiency.

Characteristics

The thermionic energy converter is a low-voltage, high direct-current device, which operates with a cathode temperature of 1200–2000 K and an anode temperature less than 1000 K depending on the work function, since a low anode work function requires a low anode temperature to prohibit electron emission from the anode.

Practical converters produce one-half to two volts and current densities of about five to ten amperes per square centimeter. However, experimental models of the plasma-type converter, using a mixture of uranium carbide and zirconium carbide for cathode material, have given short circuit densities up to 60 amp per square centimeter and power densities of 30 watts per square centimeter.

The efficiency of the practical thermionic energy converter is still too low to compete with present prime movers in our power plants, but it is expected that the efficiency can be increased to about 20 to 30 per cent as progress is made in developing better cathode and anode materials. The great potentials of the unit are the simplicity and the independence of efficiency with respect to size, which is in contrast to regular power plants where the efficiency ranges from 40 to 15 per cent depending on the size of the prime mover. Hence, once the efficiency and life of the thermionic energy converter have been increased, a power plant using thermionic units would offer attractive possibilities for use in remote areas where small power is needed, eliminating long power lines from a large plant.

NOMENCLATURE

- A = Richardson-Dushman constant 120 amp/cm^{2}K^0
- A_e = Electron-emitting area of cathode in cm^2
- A_l = Cross-sectional area of lead wire in cm^2
- A_r = Radiating area in cm^2
- e = Electron charge in Coulumb
- J = Saturation current in amperes
- J_e = Saturation current in amp per cm^2
- K = Thermal conductivity of lead wire in watt/cm C^0
- k = Boltzman constant in Joule/K^0
- L = Length of lead in cm
- P_{loss} = Energy loss in Joule or watts
- P_r = Radiative heat transfer in watts
- Q_l = Energy loss in lead wire in watts
- R_l = Resistance of lead wire in ohm
- T_a = Anode temperature in K^0
- T_e = Cathode temperature in K^0
- V_a = Anode potential in volts
- V_e = Cathode potential in volts
- V_l = Voltage drop in lead
- ϵ = Effective emissivity of the cathode anode system
- ρ = Electrical resistivity in lead wire in ohm-cm
- η = Efficiency of thermionic energy converter
- ϕ_a = Anode work function in electron volts
- ϕ_e = Cathode work function in electron volts
- ϕ_l = Energy loss in lead wire in electron volt
- σ = Stefan-Boltman constant

REFERENCE

"Direct Conversion of Heat to Electricity," Joseph Kaye and John A. Welsh, John Wiley & Sons, Inc. New York, 1960.

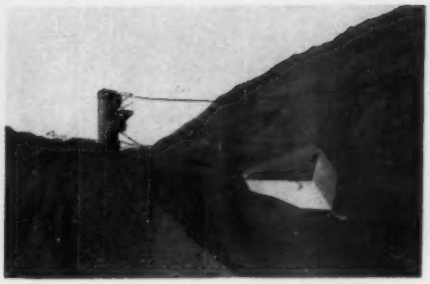
COAL—FROM MINE TO BOILER
HAULING AND RECEIVING FACILITIES

WITH THIS THIRD CHAPTER IN A SERIES WHICH STARTED IN FEBRUARY, A. S. DRUMMOND OF DETROIT EDISON BEGINS A DESCRIPTION OF THE HANDLING AND PROCESSING OF COAL BY AN ELECTRIC UTILITY

COAL is normally transported to the generating station by truck or conveyor belt if the distance is short and by rail and water for more distant locations. Use of a pipeline handling a pumped coal slurry is a recent development, and one such system is in service supplying the Eastlake plant of the Cleveland Electric Illuminating Co. Facilities for water and rail handling of coal will be presented in this article and others to follow, and will include the requirements for truck and conveyor systems.

As for power requirements for specific components: in our recent systems, the conveyor motor sizes run as high as 400 hp for a conveyor of 2200-ton capacity per hour having a 123-ft lift. Another conveyor of 2500 tons per hour capacity having an 88-ft lift is equipped with a 350-hp motor. Other motors vary in size down to 2 hp. Normal using voltage is 480 v stepped down from a primary of 4160 or 2300, whichever is available at the site. On an installation using crushers to prepare coal for firing a cyclone furnace, the 500-hp crusher motors are fed at the primary voltage (2300) without any step-down.

Water-borne coal is carried by self-unloaders, bulk carriers and/or barges. Some self-unloaders will hold over 19,000 tons of coal. Conveyor system brings coal from hold to unloading boom conveyor. Here a railroad car dumper transfers coal to self-unloader.



Dock facilities where coal is unloaded and temporarily stored are shown above and right. Dragline bucket (above right) is used to move coal into hoppers in the ramp at lower right in photo above. These hoppers feed either to rail cars or other mobile equipment for transfer to storage or conveyor system carrying coal to plant.

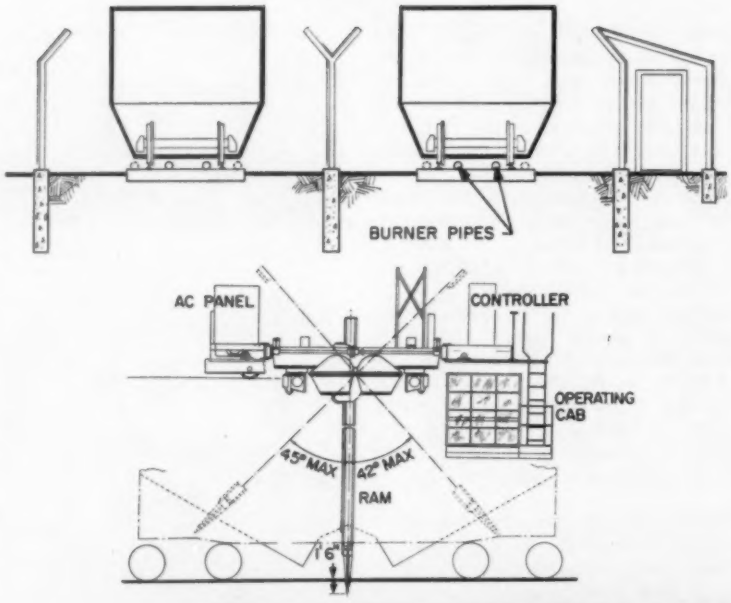
Traveling crane at waterfront unloading facility transfers coal to storage area. Mobile-type equipment, as shown, moves coal back into storage area. Reclaim may be done by returning coal to crane and loading to rail cars. Dock hopper, right, is used in large-volume systems to transfer coal immediately to the plant or to a storage area.

Barges (below) are used for water transport of coal on shallow-draft waterways. Some barges carry 1400–1500 tons. Unloading towers such as this one at the Nelson Dewey Generating Station at Cassville, Wis., are used to unload barges, can average about 800 tons an hour, with free loading rates of 1200 tons per hour.

A total of about 160 million tons of coal is burned annually in the U. S. for power generation. This accounts for over 50 per cent of the electric power generated by the 175 million kw of installed capacity. The coal is primarily bituminous with about 2 per cent lignite and anthracite; about 40 per cent is consumed in the area covered by the states of Ohio, Indiana, Michigan, Illinois and Wisconsin.

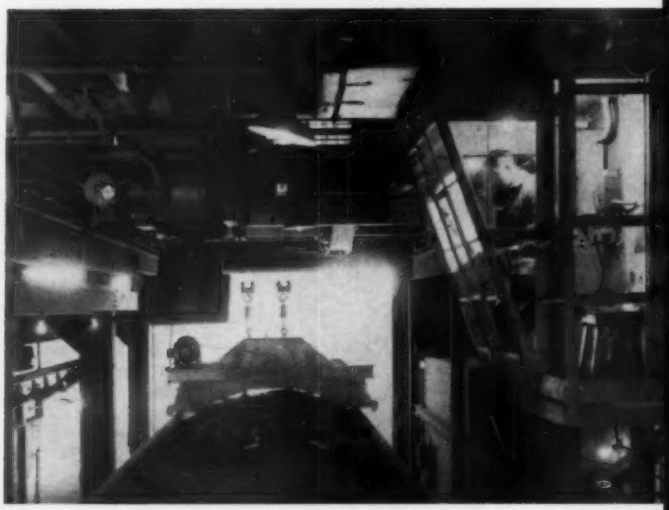
McKiernan-Terry

Rail cars are often used to deliver coal directly to power plants, and plants located on navigable water may receive a large part of the winter burn by rail to reduce amount of coal stocked during navigation. A storage area is required for rail cars, and in northern climate, thawing pits are needed for winter handling of coal. Oil and gas are usually used for thawing. Sketch shows how. Gas-fired or electric radiant panels are a more recent development.



Unloader, or equipment that shakes or knocks car, is used for initial break-through on cars that do not discharge when the gates are opened. Ram-type unloader and shake-out with control cab, shown in sketch and photo, right, uses a ram carrying a spade as its working tool. Final cleaning of coal from the car is done by vibrating equipment.

After thawing for unloading, coal cars are moved to unloading house. Shown below is a rotary car dumper used for unloading the gondola type of cars. Hopper bottom cars are emptied through the bottom gates.



REDUCE KILOVARS FOR ECONOMICAL SYSTEM EXPANSION

ROGER D. DAVIES, OF SPAULDING FIBRE CO, DESCRIBES CAPACITOR SIZING TO MINIMIZE DEMAND CHARGES AND ENLARGE SYSTEM CAPACITY

MUCH HAS BEEN WRITTEN in the technical literature relative to reducing reactive billing charges through the installation of capacitors. Perhaps, more significantly, capacitors enable an industrial power distribution system to be expanded at a minimum cost compared to the cost for additional substation equipment.

Upon completion of the Paper Mill expansion in November, 1958, our 60-cycle power demand was 2800 kva. Less than a year later, our power demand had risen to 3100 kva for the month of June, 1959. This pronounced increase was cause for considerable concern because we had only 400 kva remaining for normal plant growth before apparently being required to expand our substation.

At the Tonawanda plant of Spaulding Fibre Co, Inc, we have essentially a simple radial distribution system composed of:

1 — 3750 kva outdoor substation where 23,000 volts purchased from the public utility is stepped-down to 4160 volts. This 4160-volt, 3-phase, 60-cycle power is distributed to the following indoor unit loadcenter substations located throughout the plant.

1 — 1500 kva with four 480-volt feeders and step-down transformer for laboratory.

1 — 1000 kva with three 480-volt feeders.

1 — 500 kva with one 480-volt feeder and 2 spares.

1 — 750 kva with two 480-volt feeders (east and west).

1 — 600 kva with two 480-volt feeders (north and south).

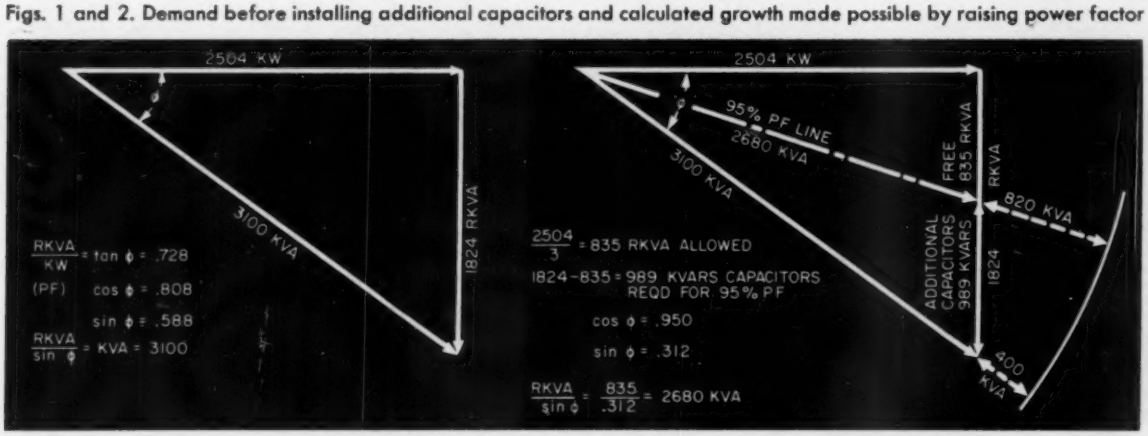
Two 23,000-volt feeders supply the outdoor substation. One feeder is a spare for future expansion.

Public utility regulations limit each feeder to a maximum demand of 3500 kva. Therefore, when our power demand approached this limiting value, we felt obliged to add another substation transformer and associated switchgear to allow use of the second 23,000-volt feeder. Estimated installed cost for this equipment was in the high five figures or low six figures. However, closer examination of our power bill data showed that substation expansion might be delayed by installing additional capacitors.

Our June, 1959, power bill revealed a demand of 2504 kw and 1824 Rkva. Figure 1 shows that our power factor was 80.8 per cent and our demand was 3100 kva. Figure 2 indicates that we had 400 kva for future plant expansion at 80.8 per cent P.F. for one feeder from the public utility.

Public utility charges include a penalty fee for any reactive demand in excess of one-third of kw demand, which corresponds to 95 per cent power factor. Referring to Figure 2, if we could raise our power factor to 95 per cent by the addition of 989 kvar of capacitors, we would have 820 kva remaining for future plant growth before

Figs. 1 and 2. Demand before installing additional capacitors and calculated growth made possible by raising power factor



being required to proceed with our substation expansion.

This looked very promising because we could obtain this expansion of electrical capacity at about 15 per cent of the cost required for the expansion of the substation. The decision was made to install 1000 kvar of capacitors.

Installation

In applying capacitors, improvement in power factor is accomplished only from the point of application back towards the source of power. We could install the capacitors either at the outdoor high-voltage substation, or grouped on the ends of the plant low-voltage feeders, or on the terminals of individual motors.

It was decided to install them at the ends of the 480-volt feeders where possible to help reduce feeder losses and improve voltage regulation. To determine how much capacitance was required on each of the 12 plant feeders we needed an accurate, portable recording meter. On each secondary feeder (at each of our unit loadcenter substations) we already had test blocks, which were originally installed by the loadcenter manufacturer.

After considerable analysis of meters commercially available, we purchased a portable recording wattmeter (3 inches per hour) together with a watt-var auto switch. Figure 3 indicates how these meters were connected to the existing test blocks and in turn to the current and potential transformers. This metering arrangement records kw for 40 seconds and Rkva for the remaining 20 seconds of each minute. Full scale of the chart is 1 kw or 1 Rkva.

Two curves are recorded on the chart; i.e. kw and Rkva respectively. Each feeder was monitored a minimum of approximately 48 hours. Some feeders having greatly fluctuating loads were monitored for a period of 96 hours.

Each feeder chart was analyzed to determine amount of capacitors required to bring the individual feeders to the desired 95 per cent power factor. For example, the kw and Rkva curves on the record chart for the 1500-kva unit loadcenter substation, feeder No. 2, were analyzed as follows:

Date	Time	Chart KW	KW/3	Chart RKVA	Reqd. KVARS For 95% PF
Feb 21	1:40 A.M.	0.33	0.110	0.51	0.400
Feb 22	2:20 A.M.	0.50	0.167	0.58	0.413*
	8:22 A.M.	0.26	0.087	0.48	0.393
	12:10 P.M.	0.28	0.093	0.49	0.397
	4:10 P.M.	0.30	0.100	0.50	0.400
	5:30 P.M.	0.20	0.067	0.47	0.403
	10:28 P.M.	0.47	0.156	0.51	0.354
Feb 23	2:12 A.M.	0.49	0.163	0.53	0.367

It can be seen that poorest power factor condition was, in this particular case, at 2:20 A.M. on February 22nd.

* Chart data for the worst condition must be multiplied by the product of P.T. and C.T. ratios, which were 4 and 200 respectively.

Actual value = 0.50 x 4 x 200 = 400 kw
Actual value = 0.58 x 4 x 200 = 464 Rkva

Figure 4 is a tabulation of these maximum kw demands

Fig. 3. Installation diagram for portable recording wattmeter to determine the capacitance required

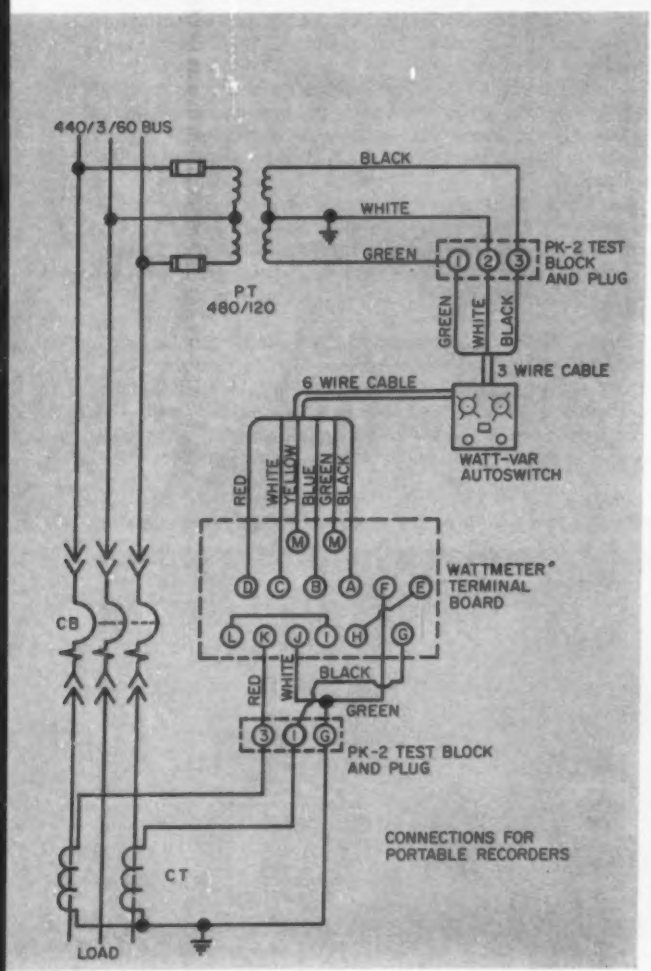


Fig. 4. FEEDER DATA BEFORE ADDING CAPACITORS

UNIT SUB-STATION	FEEDER	KW	RKVA	P.F.	KVA	Exist. cap. kvar	Req'd. added cap.
1500 kva	1	480.0	480.0	0.707	680	100	320
	2	400.0	464.0	0.652	614	100	331
	3	177.6	211.2	0.643	276	100	152
	4	220.8	43.2	0.981	225	100	−30
	Total	1278.4	1198.4		1795	400	773
1000 kva	1	268.8	43.2	0.987	272	20	−46
	2	153.6	43.2	0.962	160	60	−8
	3	316.8	124.8	0.930	341	100	19
	Total	739.2	211.2		773	180	−35
500 kva	1	76.8	9.6	0.992	77	60	−16
	Spare	—	—	—	—	—	—
	Total	76.8	9.6		77	60	−16
750 kva	East	62.4	86.4	0.585	107	—	66
	West	168.0	115.2	0.824	204	—	59
	Total	230.4	201.6		311	—	125
600 kva	North	211.2	121.6	0.867	244	—	51
	South	124.8	67.2	0.880	142	—	26
	Total	336.0	188.8		386	—	77
GRAND TOTAL		2660.8	1809.6		3342	640	924

and Rkva demands for the 12 plant feeders. From this data we determined the additional capacitance required. For example, on 1500-2:

$$\frac{400 \text{ kw}}{3} = 133 \text{ Rkva for 95 per cent P.F.}$$

464 Rkva actual − 133 = 331 Kvar reqd.

Additional capacitors were installed as follows on this feeder:

120 Kvar on starter for 200-hp wound rotor washer motor
120 Kvar on starter for 200-hp wound rotor washer motor
80 Kvar on motor control center bus
320 Kvar total

Other applications where capacitors were installed at the motor starters are:

1500 −1	120 Kvar for 200-hp wound rotor washer motor
1500 −1	120 Kvar for 200-hp wound rotor washer motor
1500 −3	80 Kvar for 100-hp wound rotor beater motor
750-East	20 Kvar for 50-hp NEMA "C" Calender motor
750-West	10 Kvar for 75-hp NEMA "B" Water Pump Motor

Fig. 5. Feeder data after adding 1000 kvar of capacitors

UNIT SUB.	FEEDER	KW	RKVA	P.F.	KVA	CAPACITANCE KVAR			
						Conn. to Bus	Switch with Motors	Total Exist	Reqd. Add'l
1500 kva	1	416.0	136.0	0.950	439	180	240	420	−3
	2	480.0	184.0	0.933	515	180	240	420	24
	3	182.4	100.8	0.875	208	160	80	240	40
	4	220.8	57.6	0.967	228	80	—	80	−16
	Total	1299.2	478.4		1390	600	560	1160	45
1000 kva	1	268.8	43.2	0.987	272	—	20	20	−46
	2	153.6	43.2	0.962	160	60	—	60	−8
	3	316.8	110.4	0.944	336	120	—	120	5
	Total	739.2	196.8		768	180	20	200	−49
500 kva	1	76.8	9.6	0.992	77	60	—	60	−16
	Spare	—	—	—	—	—	—	—	—
	Total	76.8	9.6		77	60	—	60	−16
750 kva	East	48.0	33.6	0.819	59	40	20	60	18
	West	158.4	43.2	0.964	165	60	10	70	−10
	Total	206.4	76.8		224	100	30	130	8
600 kva	North	204.8	73.6	0.940	218	60	—	60	5
	South	140.8	57.6	0.925	152	30	—	30	11
	Total	345.6	131.2		370	90	—	90	16
GRAND TOTAL		2667.2	892.8	0.948	2829	1030	610	1640	4

Figure 5 is a tabulation of maximum kw demands and Rkva demands for the 12 feeders after the capacitors were installed in June, 1960.

Figure 6 shows graphically the results obtained by the installation of 1000 kvar of capacitors. Figure 7 indicates that for July, 1960, we had 810 kva remaining for future plant expansion at 93.7 per cent power factor on the one public utility feeder.

Prior to the installation of the additional capacitors, the average monthly reactive, in excess of one-third of kw demand, was 979.9 Rkva. At 25 cents per Rkva the average penalty charge was $244.98 per month. The July, 1960, reactive charge was for 97 Rkva, equal to $24.25. Apparent monthly saving is $220.73, which will amortize the cost of the additional capacitor installation in about 55 months or approximately 4½ years.

General Observations

It has been observed that the capacitors connected directly to the Motor Control Center Bus operate at higher temperatures when Rkva load is small, as on weekends, compared to lower temperatures when Rkva load is high during full operations.

Capacitors raise the voltage of feeders in accordance with the following formula:

$$\text{Per cent voltage rise} = \frac{\text{kvar capacitors x per cent transformer impedance}}{\text{kva of unit loadcenter transformer}}$$

For example, the following voltages were calculated and observed on all the secondary feeders of the 1500-kva unit loadcenter substation.

Capacitors Connected	Feeder Load Conditions	Observed Voltage	Calculated Voltage
None	No-load	474 (base)	
400 kvar	No-load	480 @ 1.36% rise	480 @ 1.36% rise
400 kvar	Full operation	430 (base)	—
600 kvar	No-load	490 @ 3.5% rise	484 @ 2.15% rise
1160 kvar	Full operation	465 @ 8.0% rise	442 @ 2.79% rise

These "full load" voltages are well within the desired operating voltage range, which should be between 396 and 484 volts as specified by NEMA standards for 440-volt motors.

It should be noted that actual voltage rise is somewhat greater than that calculated. This results from the fact that motors running at the higher voltages, due to capacitors, draw less line current which further raises the voltage level.

Installing the additional capacitors raised our power factor from 80 per cent to approximately 93.7 per cent, reduced our kva demand about 15 per cent, and more than doubled remaining kva demand capacity for future plant growth. END

Fig. 6. Result obtained by installing additional capacitors

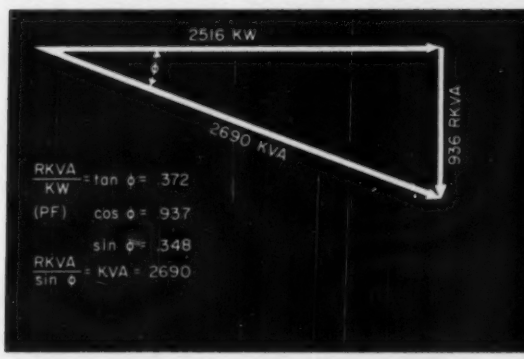
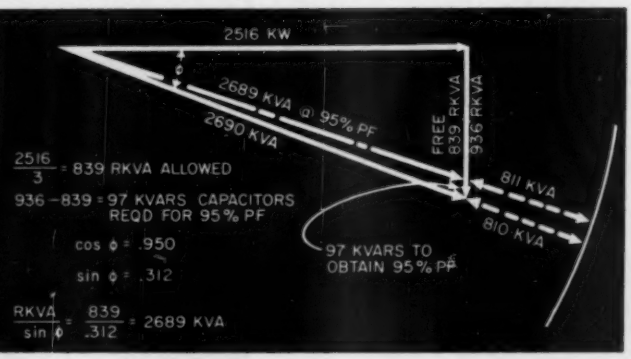


Fig. 7. Present conditions and room for additional growth


2516 KW
φ
2689 KVA @ 95% PF
2690 KVA
FREE 839 RKVA
936 RKVA
811 KVA
810 KVA
97 KVARS TO OBTAIN 95% PF
2516 / 3 = 839 RKVA ALLOWED
936 − 839 = 97 KVARS CAPACITORS REQD FOR 95% PF
cos φ = .950
sin φ = .312
RKVA / sin φ = 839 / .312 = 2689 KVA

BAGHOUSE CURES STACK EFFLUENT

MUNICIPAL INCINERATOR IN PASADENA, CALIF., FINDS A NEW WAY TO GET RID OF THAT STACK PLUME. C. O'CONNOR AND GLENN SWINEHART OF THE CITY'S LIGHT AND POWER DEPT DESCRIBE WHAT IS BEING DONE

ABOUT TWO YEARS AGO the Los Angeles County Air Pollution Control District adopted a resolution which banned the use of backyard incinerators. As a result, rubbish which before this had been burned in backyards was collected for disposal at the Pasadena Municipal Incinerator. In order to handle the increased load the incinerator was expanded to almost double its capacity — to a peaking capacity of about 300 tons a day. As part of this expansion program a new induced draft fan and a new stack were installed on one of the two units which comprise the plant (Fig. 1).

This required approval from the Los Angeles County Air Pollution Control District, and it was found necessary to install some form of flue gas washing device. We were aware of the success obtained in other industries with use of a water-type scrubber, so we decided to try this type on one of the incinerator units.

We found that the scrubber would reduce the grain loading to within acceptable limits, but opacity still exceeded the allowable three minutes an hour. It was evident that we would have to carry on additional work in order to achieve further reduction of the particulate matter getting through to the stack.

Even though the efficiency of the scrubber is in the high 90's, the particulate matter that did get through could still create a plume. We found that particles below one micron in size were causing the plume. Materials of this size comprised only a few per cent of the total matter, so the efficiency of the particulate collecting device would have to be almost 100 per cent. It was felt that a filter as such was the only device which could remove this very fine matter, so we decided to experiment with a pilot baghouse.

The pilot baghouse (Fig. 2) is 18 in. in diameter by 30 ft high, with access openings at the bottom and top, and a hopper at the bottom for removal of collected material. A single bag 11½ in. in diameter by 25 ft long is connected at each end to 11¼ in.-diam nipples which in turn are welded to a tube sheet.

The flue gas sample is taken at the boiler outlet duct and travels in a 4 in.-diam pipe to a plenum chamber at the top of the baghouse. The gases then pass out of the plenum chamber, through the pipe nipple and inside the bag. Flue gases then filter through the Fiberglas bag and out the bottom of the baghouse to the fan suction. Filtered gases leave the fan discharge through a pilot stack 6 in. in diameter by 25 ft high.

Bypass piping was also installed, permitting a comparison between the plumes of filtered and non-filtered flue gas, and there is very complete instrumentation to provide temperature and pressure drop information at various strategic points.

Operation

The pilot unit was started and, with the exception of short shutdown periods for revision, has been operating on a 24-hour, round-the-clock basis. The incinerator is secured during the weekends for maintenance, during which time the baghouse is also secured. Readings are periodically taken to determine temperature, pressure drops, etc. (See Fig. 3.) A timer controls the cleaning cycle and the hopper must be emptied manually.

The filter bag is of silicon-treated Fiberglas, 25 ft long and of 11½ in. diam, with a permeability rating of 81. Filter velocity is approximately 5 fpm with a pressure drop range of from 3 to 5 in. of water across the bag and a flue gas flow of 375 cfm.

Cleaning of the bag takes place as follows:

Baghouse inlet line is connected to a negative pressure zone; so by securing the fan unit we achieve a lower pressure inside the bag than out, hence the bag collapses against a "spider" (pipe framework), and air flow is in a reverse direction for a period of four minutes. This collapse and reverse flow loosens dust particicles, permitting them to fall into the bottom hopper. The fan then starts, actuated by a timer, and the bag reinflates.

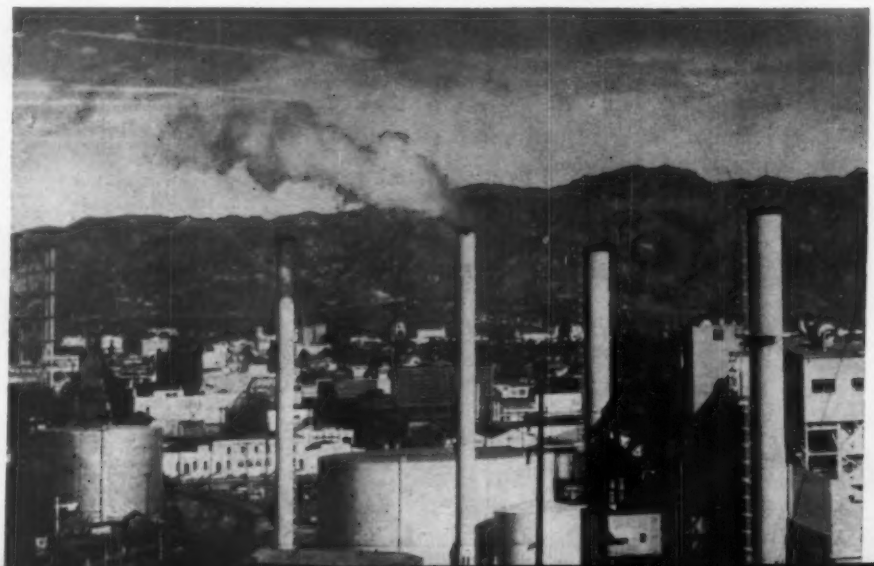
Inlet temperature range is extreme due to unusual fuel and firing conditions, i.e., wet or dry brush, wood, etc, all affect gas temperature. Inlet temperatures have been measured as low as 300 F and as high as 750 F.

Results

The baghouse was first put into operation on October 15, 1959, and the test program has provided the following results:

1. There is no visible plume from baghouse effluent. Inlet loading is

Fig. 1. Incinerator stacks at left. Pilot baghouse effluent is without plume



approximately 13.4 grains per cu ft, while outlet loading is 0.031 grains per cu ft, which represents an efficiency of 99.77 per cent. This is within APCD's requirement of No. 2 Ringelmann maximum capacity and 0.3 grains per cu ft of maximum dust load.

2. We feel at this stage that if high flow ratios can be obtained to reduce the number of bags required and the physical size of the baghouse, this type of dust filter would be competitive with other less efficient collectors.

3. We do not yet have sufficient operating time on our baghouse to evaluate the question of bag life. We can only say that we encountered no serious problems in the first year of operation.

4. For our particular application it appears that the cleaning cycle will have to be 45 to 60 minutes.

5. To date, a 5:1 flow ratio, i.e., 5 cfm per sq ft of filter surface, is the highest we have been able to achieve and still maintain a pressure drop below 5 in. water. However, we are presently experimenting with an improved and more frequent cleaning method which we hope will increase the flow ratio even more.

6. Our present operating temperatures, averaging 500 F, have had no adverse effects on the filter fabric to date.

7. Shutdown periods seem to have no effect on filter fabric.

8. The reverse flow method of cleaning has been quite successful; however, as mentioned above, we feel that even lower pressure drops can be obtained with more refined cleaning methods, i.e., more positive collapse of bag with auxiliary fan.

9. Our test program has not yet been completed, but where high efficiency collection is required, as is the case in Los Angeles County, the baghouse appears to be the least costly of the few devices available for incinerator application.

Elaborate studies have been conducted by various agencies, both public and private, to determine what causes a plume. Evidence has been accumulating which points to sulfur trioxide as a major plume-forming constituent.

In view of this, and since there is no available plume at all at the pilot baghouse stack, it was the writer's feeling that SO_3 was being filtered out by the baghouse. To prove or disprove this theory, an independent laboratory was called upon to obtain flue gas samples from the stack of our pilot baghouse. As mentioned above, the test unit is equipped with bypass piping, permitting us to compare non-filtered and filtered effluent. Flue gas samples were obtained from each and analyzed for SO_3.

Results of this test showed SO_3 concentration in non-filtered flue gas to be 27.3 ppm. Filtered flue gas showed concentration had been reduced to 1.6 ppm.

Obvious conclusion to the above findings is that the baghouse, while efficiently removing particulate in the sub-micron size range, is also capable of removing a large percentage of the SO_3. END

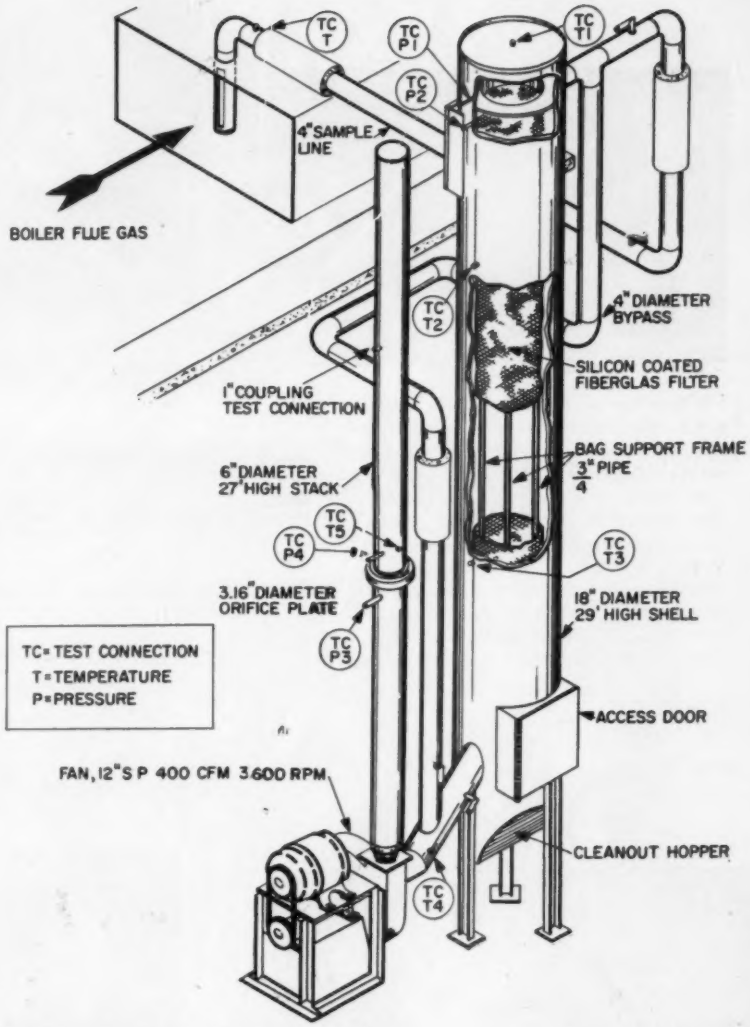
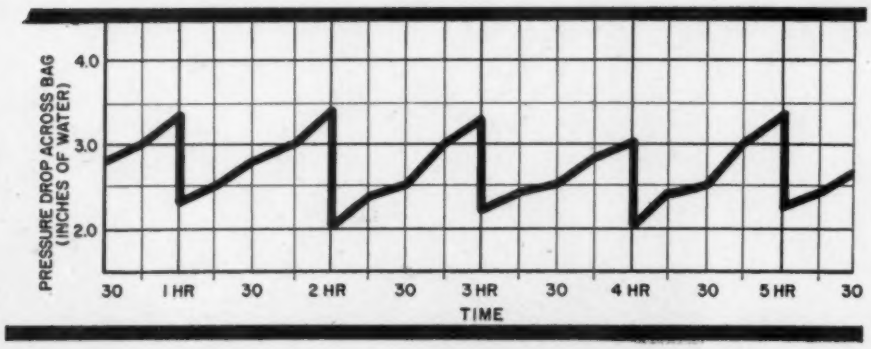


Fig. 2. Pasadena's pilot baghouse efficiently removes particulate of sub-micron size. Also removes large percentage of the SO_3 responsible for plume-forming

Fig. 3. Readings were taken periodically to determine pressure drop curve

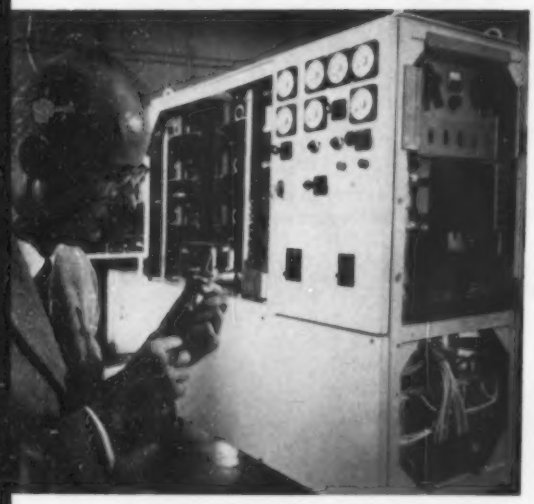


8-ton "nutcracker" is newest addition to nuclear hardware at AEC's Hanford plant. It cuts tough, radioactive stainless steel pipe into small, manageable pieces for waste burial. Brain-child of GE engineers, the device is remote-controlled, saves on costs of disposal job of wornout pipes

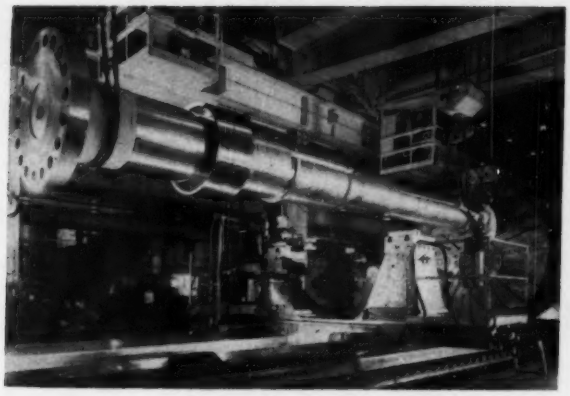
Philadelphia Electric Co's automatic digital computer-controlled system will be directed from this console when it is placed on line in the next few months. It will assign total generation requirements on most economical basis and provide cost data on power interchanged. John W. Hoag (left) of Minneapolis-Honeywell explains details to Armand C. Hartranft, chief load dispatcher, and John R. Stauffer, project engineer, both of the power company

Power Engineering's

Patrol of 80-mile power line by plane cuts job-time from 9 days on foot to 3 hours. Louisville Gas & Electric (Ky.) has been using this method since 1950. Plane flies at 150 ft. Any serious defect is reported by short-wave radio to plane's base for relaying by phone to the company's trouble-shooters

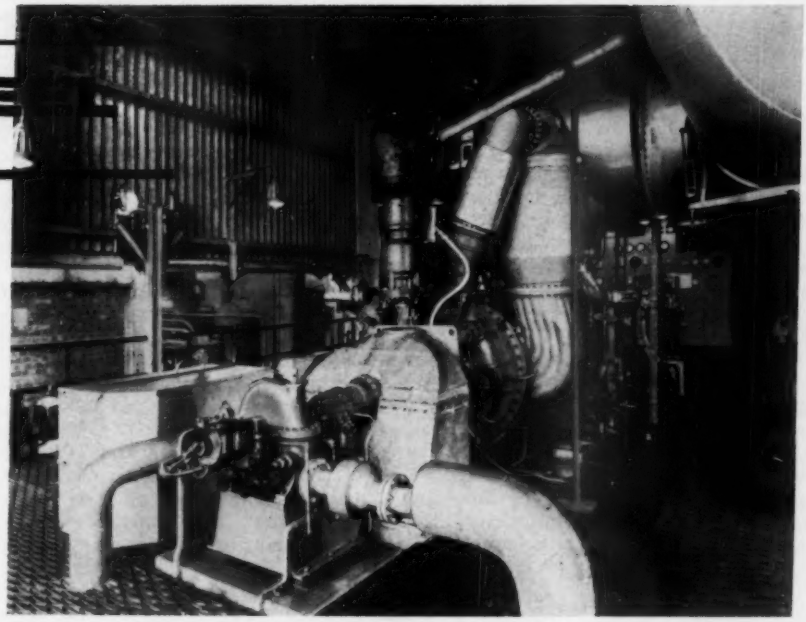


New inverter, with rating of 50 kva, and using silicon rectifiers, has had successful lab test at GE. It has no moving parts, other than two fans, and does the work of a 60-hp motor-generator set in converting dc to ac. Here R. A. Koehler inspects the device's key component. The new inverter has 10 times the power-handling capacity of units of this type announced up to now, is expected to have important use in applications involving fuel cells, solar energy



This 89,200-lb shaft is for a 95,000-kw, 180-rpm turbine-driven generator at U.S. Bureau of Reclamation's Unit No. N-8 at Hoover Dam. The 34-ft-long unit is shown here being removed from engine lathe at Allis-Chalmers plant. The generator is 17th and last major unit for the big Colorado River project, will raise plant to 1,344,800 kw

NEWS RE



17,000 hours of trouble-free operation is record made by this English Electric EM27 gas turbine. It's been in commission two years without a standby at Esso Petroleum Co's Fawley Refinery in Britain, and is directly coupled to multi-stage gas compressor

Steel sections 24 ft in diam, made by U.S. Steel, will line power tunnels in huge earth-filled dam near Pierre, S.D.

HOW WE TRAINED FOR A NEW STEAM ELECTRIC PLANT

R. C. ALEXANDER, ENGINEER OF STEAM PLANTS FOR LOS ANGELES, HERE DESCRIBES AN OUTSTANDING TRAINING PROGRAM

CONSTRUCTION of the Scattergood Steam Plant of the Los Angeles Dept of Water and Power was begun in 1957. This is a centrally controlled plant of high-pressure, high-temperature with two units of 160 Mw each (Fig. 1). With the plant's completion, the Department's system generating capacity became 2,003,000 kw, of which 1,329,000 or 66 per cent is steam. However, the system kwh demand is now furnished 80 per cent by steam and 20 per cent by hydro.

The over-all program of operator training for the new plant had four major parts: organization, the production of an operators' instruction manual, the initial training program, and the training of new personnel.

Getting Under Way

Eleven months prior to the scheduled operation of Scattergood Steam Plant Unit No. 1, the superintendent and his chief clerk were transferred to the plant site from other Department steam plant facilities. At this time, designs were practically complete and construction well advanced.

These men occupied two 50-ft office trailers on the plant site and prepared the way for the forthcoming program.

During this same period an organization plan and a schedule of hiring (Fig. 2) were developed for the approval of management. Simultaneously, procedures for producing an operating manual were worked out and put down in writing in the form of an Outline and Guide. Copies of this Outline were printed for the instruction of those subsequently made responsible for the writing of the operating instruction manual.

Following this, the first group of personnel was hired. These were the six shift supervisors, three instrument technicians, and one additional clerk. All were experienced individuals transferred from older plants for the purpose of writing the manual, to construct the training program and later to start up and supervise shift operations. These men were the training program's "instructors."

Although none of these people had a background of technical writing, it was felt that their years of experience (5 to 20) would make them more capable of producing a practical operating manual than individuals from design, manufacturing or training organizations. This belief has been amply proved by subsequent experience and results.

Each instructor was given a copy of the Outline and Guide and was instructed to follow its format implicitly. They were also assured that they need not worry about misspelling, punctuation or grammatical errors, since the material would be reviewed and edited as required. This assurance worked wonders and the men wrote freely in an uninhibited manner.

One instructor was assigned to coordinate the activities of this group with the design engineers, manufacturing representatives, drafting room, and other supporting groups. He also obtained the drawings, flow diagrams, manufacturers' instruction bulletins, and other data necessary to production of the operating manual.

Subject assignments for preparation of the manual were made to those persons most familiar with the various systems or equipment. Shift supervisors wrote the sections devoted to all mechanical and electric systems, including boiler, turbine and auxiliaries. Instrument technicians

Fig. 1. Scattergood Steam Plant has increased system capacity to 2,003,000 kw

J. A. Novobilski, mechanical engineering associate, and J. W. Myers, assistant superintendent of Scattergood Steam Plant, assisted both in preparing the training program and this article.

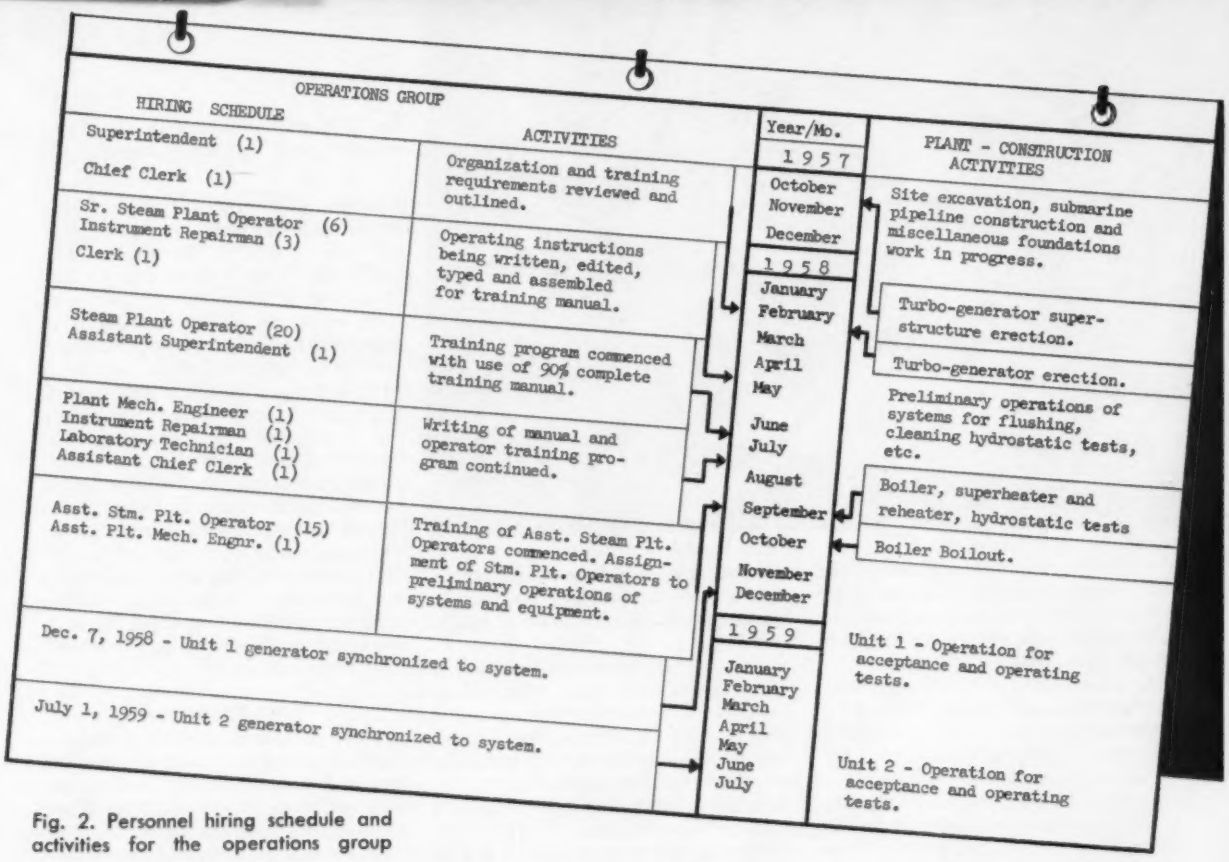


Fig. 2. Personnel hiring schedule and activities for the operations group

were assigned all control systems and related instrumentation. The laboratory technician prepared all instructions relating to water treatment and chemical control. The superintendent edited and reviewed material prior to final draft.

The effectiveness of this method may be seen in the fact that the major portion of the manual was completed in a three-month period. It comprised 170 pages of instructions covering 90–100 systems and/or equipment, 18 equipment drawings, 47 mechanical, control and electrical schematics, three operating curves and three "block" diagrams.

We Write the Manual

Analyzing concepts and objectives in the light of previous experience and review of training programs of other utilities, it became apparent that too much emphasis had formerly been placed on details such as pipe size, thickness, chemical composition, etc. Such details were seen to be irrelevant to the purpose of the manual, which was to give normal operating instructions.

Each system in the plant is given separate treatment in the manual. With brevity as the keynote, the function of each system is defined followed by a brief description of it, excluding non-essential details not related to operating requirements, and a simplified explanatory drawing.

Following this, actual operating instruction is given, by the action-purpose method — that is, by emphasizing the normal sequence of operation, and including the "why" or "purpose" explanation.

When operating precautions, observations, or emergency conditions should be recognized, such a statement is placed in the manual between the steps of operation. This forces special recognition of these factors upon the operator.

System schematics showing piping, controls and equipment related to operating instructions were roughly drafted by the instructors on the right-hand half of 11 by 17-in. paper. These were then finish-drawn by Department draftsmen. This method of presentation allows the reader to fold-out the sketch for continuous reference.

In addition, major control diagrams were produced in "block" form. Complex trip and/or restore actions involving combinations of electrical, mechanical, pneumatic and hydraulic systems are reduced to a single diagram showing the sequence and line of operation. From this type of diagram the operator can quickly analyze the sequence of events from one of many components of a complete system complex.

On May 1, 1958, the instructors reported to the plant site. They were each furnished a copy of the Outline and Guide and half a day was spent discussing the philosophy and details of the manual to be written. The remainder of the day was spent inspecting the plant, getting their materials organized for the forthcoming writing, and being assigned the portions which they were to write.

The instructors occupied one of the office trailers and the superintendent and his clerks the other. This separated the instructors from the distraction of typing and also provided a quieter atmosphere for the superintendent, who edited the write-ups, some of them several times.

The rapid development of these men was a pleasure to observe. In the first few days voluminous "function" and "description" manuscripts flew back and forth between the trailers, but soon the required brevity of writing was understood and forthcoming.

The close contact between operating and technical personnel provided the essential interchange of related data between them. When complicated operating or control problems arose, general discussions, sometimes loud and clear, were the order of the day.

As a side benefit, this same close contact welded the group into a team with a common goal. This fine spirit

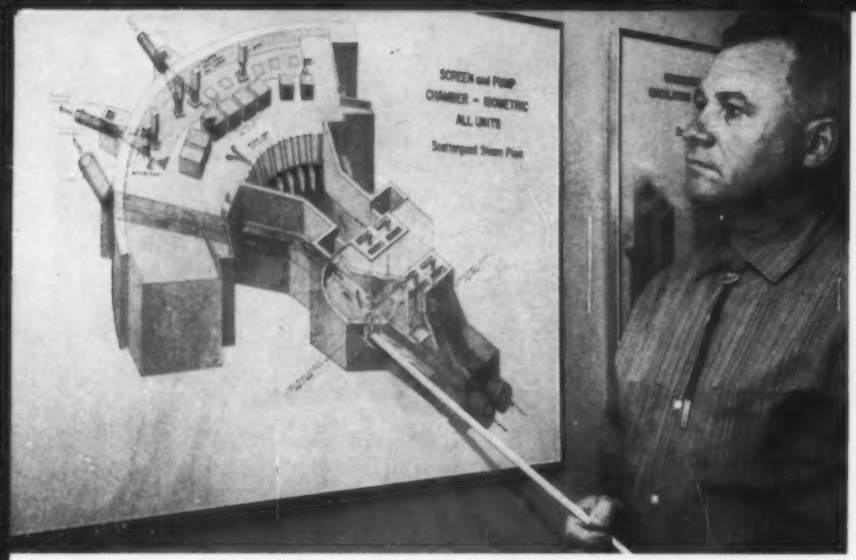


Fig. 3. Isometric drawings, 30 by 48 in., in color, are important training aid

of enthusiasm continues today and has infused itself into the operating personnel who followed and who are now engaged in operating the completed plant.

At the end of July, 1958, the manual was essentially complete and the preliminary copies were printed by the Ditto method so that any corrections found necessary could be incorporated into the final printed form.

The material was then made into a single volume contained in a three-ring binder and became part of an operator's assigned equipment. The final printing was accomplished one year later and a reissue was made to each operator.

Initial Training Program

In view of the fact that these instructors would eventually become the shift supervisors and would have total responsibility for shift operation, it was necessary that they, in turn, be given training in the phases of the plant which they did not write up.

This required little effort, for during the period of preparing the manual, the experience and enthusiasm of these men resulted in almost continuous discussions about system and equipment instructions. Supervisors and technicians would frequently attend the regular sessions given to the operators by other supervisors. This supplemented their general knowledge.

All instructors participated in the review of all instructions before editing and typing. From this and by conferences attended by all supervisors, many problems were discussed which expedited the early establishment of a final procedure of operation.

Introduction to new equipment and system design was presented to the supervisors by the system design engineers and manufacturers' representatives. The purpose of these lectures was to present unusual design and equipment features requiring consideration for normal operation.

As a result of these experiences these men were well prepared to conduct a comprehensive training program for the steam plant operators and the assistant operators and to supervise the operation of the various components of the new plant.

The operators were issued a complete set of system diagrams and the training manual, which was 90 per cent complete at that time. With this material, instruction was presented in scheduled classroom and field meetings by the supervisory and technical personnel assigned to the respective sections of the manual.

Time spent in class was generally two hours followed by field trips of two hours and concluded with an examination after completion of a system or equipment procedure. Additional discussion prior to or following the examination was encouraged, to promote more complete knowledge of the systems or equipment being studied. Problems or questions often led to additional research or more detailed diagrams to aid in developing system or equipment operation.

Training aids used for instruction included a large blackboard, slide projector, and expanded drawings of equipment, flow and control diagrams and large isometric drawings of piping systems. The slide projector was used to show cuts and details of equipment.

Field trips were included to present the physical systems as related to size, location, accessibility and actual construction and assembly. These trips gave the operators a "feel" for the plant and its components.

Length of the basic introductory training course for operators was seven weeks, with three weeks for assistant operators, instruction being given eight hours per day. The enthusiasm which developed from the program resulted in many hours spent by the operators on their own time in study of the systems and equipment. This interest, in itself, was rewarding and most beneficial in forming a well-coördinated operating group, as well as the supporting groups of maintenance, technical and staff personnel.

As the operation of the plant continues, the search by all personnel for additional knowledge of the equipment, systems and operation continues. New personnel are received with enthusiasm into a program which has proved its ability to train effectively and integrate them into the team.

New Personnel

New personnel are hired after a regular examination and screening established by the Civil Service system under which we operate. When selected they are assigned to a definite program of introduction and training administered by a plant training supervisor. This training is uniform and is conducted according to a scheduled training progress report. Use of this report form enables the new employee to prepare himself for each day's training session by home-study of the pertinent materials in his manual.

With the aid of 30 by 48-in. isometric drawings of the piping systems in color, as shown in Fig. 3, and with the actual physical piping systems, the trainee is assigned to make isometric sketches of the physical piping of various systems. The sketches are made to include the valving, cross connections, and normal direction of flow and provide familiarity with the related equipment.

On completion of the sketches, the training supervisor checks the system sketch and returns it with corrections or additions and comments on the need for complete and exact sketches. These completed sketches are kept by the trainee for future reference and discussion during later stages of instruction. Basic instruction can be scheduled for rotating shift employees, while still meeting plant manpower requirements.

To insure a comprehensive program of training for each operator, the basic training outline is followed and a record is maintained by the training supervisor for each operator participating in the program. END

HOW WATTMETERS ARE CALIBRATED AND CONNECTED

R. M. ROWELL OF GENERAL ELECTRIC'S INSTRUMENT DEPARTMENT

CONCLUDES HIS DISCUSSION OF WATTMETER CONNECTIONS

CORRECT circuit connections are extremely important, especially in the case of polyphase wattmeters. It has been determined that a standard two-element wattmeter connected on a 3-wire, 3-phase circuit can have 30 possible connections of which only one is correct. The diagrams which accompany the article are necessarily schematic and may not represent the actual location or arrangement of terminals. It is important, therefore, to follow very carefully the Instruction Book or the diagrams normally furnished with these devices.

Phase-angle meters may be of invaluable aid in checking connections where circuit markings are questionable or non-existent.

Various methods of checking connections have been described in electrical metering texts and published articles. Two deserve consideration:

1. The Kouwenhoven Check (see AIEE Transactions 1916). This check applies to a standard two-element wattmeter on a 3-wire, 3-phase circuit with approximately balanced loads at any power factor. The two potential leads connected to the lines from which current is supplied to the current coils (normally lines 1 and 3) are interchanged, and under this condition the instrument should read close to zero if the remaining connections are correct.

2. The Ackerman Check (see *Electrical World*, Jan 17, 1914). This is used on a two-element, polyphase wattmeter connected to a 3-wire, 3-phase circuit having a common connection to 2 potential coils under condition of loads which are not unbalanced by more than 25 per cent. Here, the line connection to the common lead is removed, leaving the two potential coils connected in series across the third phase (normally line 1 to line 3). If the connections are incorrect, the instrument will have reversed deflection (assuming that it read up-scale initially and that the proper voltage and current sources are connected to each element).

When considering connections other than those recommended, study the limitations carefully with the following questions in mind:

1. What unusual sources of error are present?
2. Does the application justify readings of reduced accuracy?
3. Are the frequently made assumptions of balanced currents and voltages valid?
4. Will the application require instruments of special construction or calibration?
5. How will unusual current transformer connections affect relaying and other instrumentation?

When ordering instruments for any special application or unusual connection, give full details to the instrument manufacturer with a schematic connection diagram, since considerable confusion can exist in this area.

With these considerations in mind, it is possible to obtain, connect, and to check indicating or recording wattmeters with confidence.

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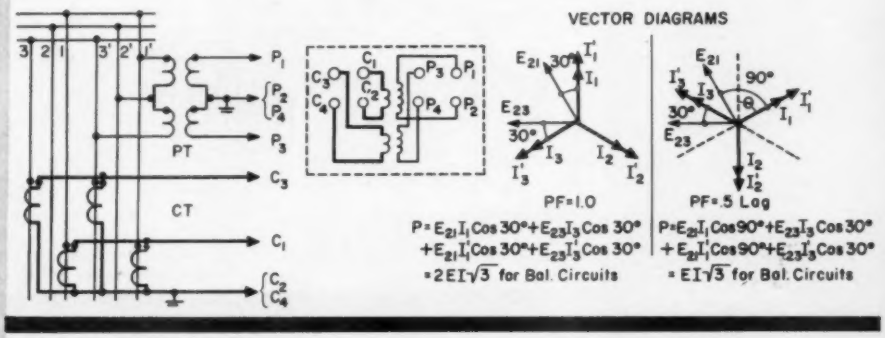
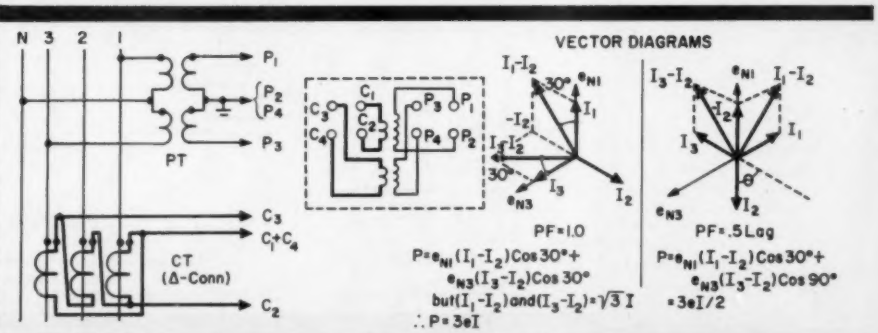
Metering: Total watts on 3-phase, 3-wire double circuit
Transformers: 2 potential, 4 current trans.
Instrument: 2-Element wattmeter
Special Features: 10 ampere current coils (or aux. current trans.)
Limitations: Common potential source Combined trans. ratios alike
Cal. Watts = Scale in watts × P.T. ratio × C.T. ratio × 2



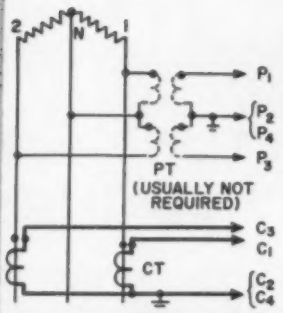
12

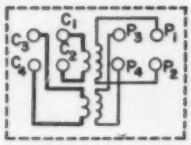
Metering: Watts on 3 phase 4 wire
Transformers: 2 potential, 3 current trans.
Instrument: 2-Element wattmeter
Special Features: Preferably 8.66 ampere coils
Limitations: Balanced voltages
Cal. Watts = Scale in watts × P.T. ratio × C.T. ratio × 2



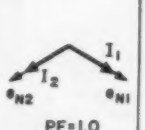
13

Metering:
Watts on 3 wire 120 degrees (from 3 phase 4 wire)
Transformers:
2 potential, 2 current trans.
Instrument:
2-Element wattmeter
Special Features:
None
Limitations:
None. Standard connection
Col. Watts =
Scale in watts
P.T. ratio x C.T. ratio x 2





VECTOR DIAGRAMS



PF=1.0

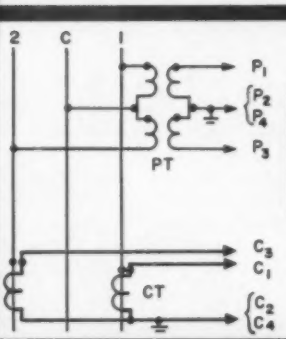
$P=e_{N1}I_1+e_{N2}I_2$
$=2eI$ for Bal. Circuit

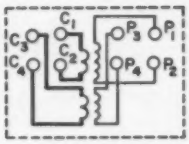
PF=.5 Lag

$P=e_{N1}I_1\cos 60°+e_{N2}I_2\cos 60°$
$=.5e_{N1}I_1+.5e_{N2}I_2$
$=eI$ for Bal. Circuit

14

Metering:
Watts on 2 phase 3 wire
Transformers:
2 potential, 2 current trans.
Instrument:
2-Element wattmeter
Special Features:
None
Limitations:
None. Standard connection
Col. Watts =
Scale in watts
P.T. ratio x C.T. ratio x 2

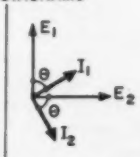




VECTOR DIAGRAMS

PF=1.0

$P=E_1I_1+E_2I_2=2EI$

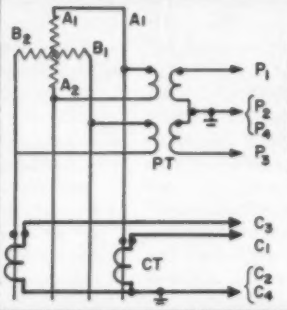


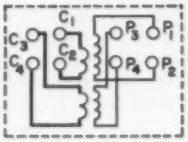
PF=.5 Lag

$P=E_1I_1\cos 60°+E_2I_2\cos 60°$
$=.5E_1I_1+.5E_2I_2=EI$

15

Metering:
Watts on 2 phase 4 wire
Transformers:
2 potential, 2 current trans.
Instrument:
2-Element wattmeter
Special Features:
None
Limitations:
None. Standard connection
Col. Watts =
Scale in watts
P.T. ratio x C.T. ratio x 2

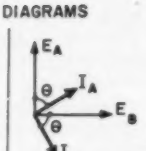




VECTOR DIAGRAMS

PF=1.0

$P=E_AI_A+E_BI_B$
$=2EI$ for Bal. Circuit

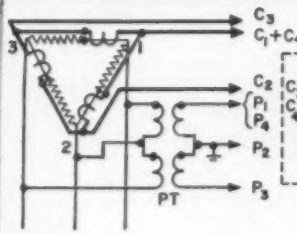


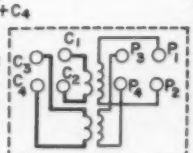
PF=.5 Lag

$P=E_AI_A\cos 60°+E_BI_B\cos 60°$
$=.5E_AI_A+.5E_BI_B=EI$

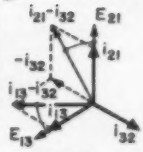
16

Metering:
Watts on 3 phase 3 wire delta with C.T. inside delta
Transformers:
2 potential, 3 current trans.
Instrument:
2-Element wattmeter
Special Features:
Preferably 8.66 amp current coils
Limitations:
Balanced voltages
Col. Watts =
Scale in watts
P.T. ratio x C.T. ratio x 2



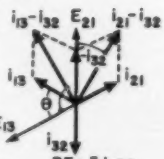


VECTOR DIAGRAMS



PF=1.0

$P=E_{13}(i_{13}-i_{32})\cos 30°+$
$E_{21}(i_{21}-i_{32})\cos 30°$
but i = Phase Cur. $\therefore(i_{13}-i_{32})$ and $(i_{21}-i_{32})=\sqrt{3}I$ or Line Cur. I
$P=2EI\cos 30°=\sqrt{3}\,EI$

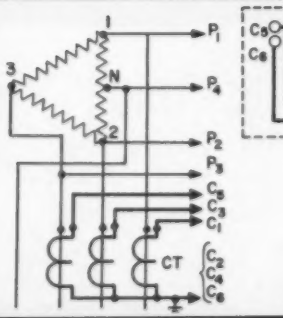


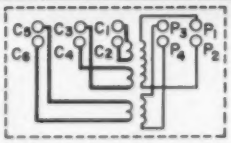
PF=.5 Lag

$P=E_{21}(i_{21}-i_{32})\cos 30°+$
$E_{13}(i_{13}-i_{32})\cos 90°$
since $(i_{21}-i_{32})$ and $(i_{13}-i_{32})$ = Line Cur. I
$P=\sqrt{3}/2\,EI$

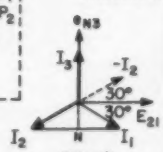
17

Metering:
Watts on 3 phase 4 wire delta
Transformers:
3 current transformers
Instrument:
Special 3-current, 2-potential wattmeter
Special Features:
2 current coils in 1 element
Limitations:
Balanced center-tap voltages
Col. Watts = Scale in watts / C.T. ratio x 2



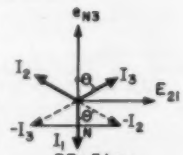


VECTOR DIAGRAMS



PF=1.0

$P=e_{N3}I_3+E_{21}I_1\cos 30°+$
$E_{21}I_{-2}\cos 30°$
but $E_{N3}=.866E$ also I_1 and I_2 Have 1/2 Turns on Current Coil
$\therefore P=.866EI+.5(.866EI+.866EI)=\sqrt{3}\,EI$

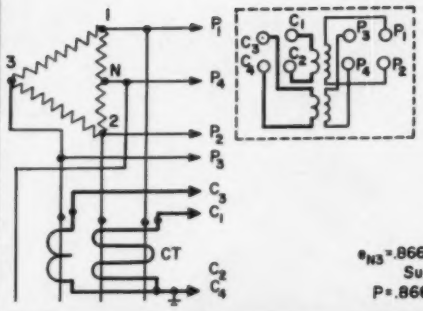


PF=.5 Lag

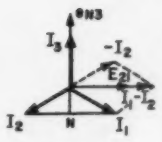
$P=e_{N3}I_3\cos 60°+E_{21}I_{-2}\cos 30°+$
$E_{21}I_1\cos 90°$
$e_{N3}=.866E$ and I_1 and I_2 Have 1/2 Turns
$P=.5(.866EI+.866EI+0)=\sqrt{3}/2EI$

18

Metering:
Watts on 3 phase 4 wire delta
Transformers:
2 current transformers
(1 double primary)
Instrument:
2-Element wattmeter
Special Features:
None
Limitations:
Balanced center-tap voltages
Cal. Watts = $\frac{\text{Scale in watts}}{\text{C.T. ratio} \times 2}$



VECTOR DIAGRAMS

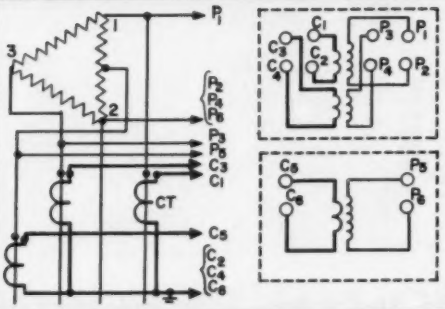


PF=1.0
$P=e_{N3}I_3+E_{21}(I_1-I_2)$
$e_{N3}=.866E$ and $(I_1-I_2)=1/2$ Vector Sum of I_1 and I_{-2} or $.866I$
$P=.866EI+.866EI=\sqrt{3}EI$

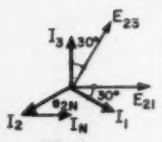
PF=.5 Lag
$P=e_{N3}I_3\cos 60°+E_{21}(I_1-I_2)\cos 60°$
$e_{N3}=.866E$ and $(I_1-I_2)=.866I$
$P=.5(.866EI+.866EI)=\sqrt{3}/2EI$

19

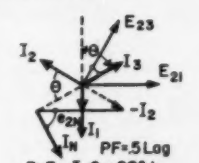
Metering:
Watts on 3 phase 4 wire delta
Transformers:
3 current transformers
Instrument:
Single element plus
2-Element wattmeter
Special Features:
None. Single phase = 120 v
3-phase = 240 v
Limitations:
Balanced center-tap voltages on single-phase instrument. Two-element meter is standard.
Cal. Watts (2-element) =
Scale in watts
C.T. ratio x 2
Cal. Watts (1-element) =
Scale in watts
C. T. ratio



VECTOR DIAGRAMS



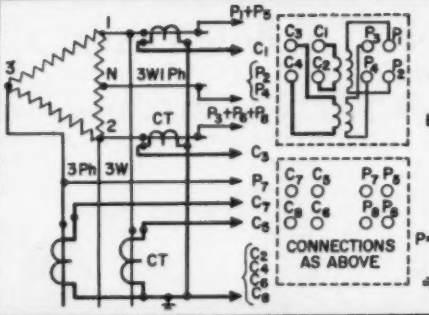
PF=1.0
$P=E_{21}I_1\cos 30°+E_{23}I_3\cos 30°+e_{2N}I_N$
$=\sqrt{3}EI+eI_N$



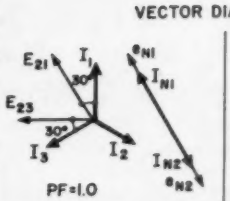
PF=.5 Lag
$P=E_{21}I_1\cos 90°+E_{23}I_3\cos 30°+e_{2N}I_N\cos 60°$
$=\sqrt{3}/2EI+.5eI_N$

20

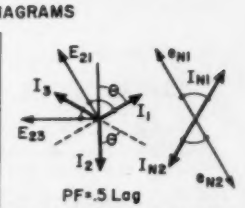
Metering:
Watts on 3 phase 4 wire delta
Transformers:
4 current transformers
Instrument:
Two 2-element wattmeters
Special Features:
None
Limitations:
Balanced center-tap voltages
Cal. Watts (both meters)
= Scale in watts
C.T. ratio x 2



VECTOR DIAGRAMS



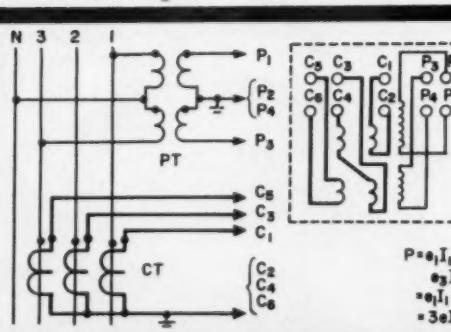
PF=1.0
$P=E_{21}I_1\cos 30°+E_{23}I_3\cos 30°+e_{N1}I_{N1}+e_{N2}I_{N2}$
$=\sqrt{3}EI$(for 3Ph)$+2e$I for 1Ph3W



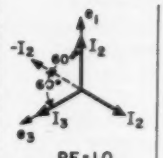
PF=.5 Lag
$P=E_{21}I_1\cos 90°+E_{23}I_3\cos 30°+e_{N1}I_{N1}\cos 60°+e_{N2}I_{N2}\cos 60°$
$=\sqrt{3}/2EI$(for 3Ph)$+e$I for 1Ph3W

21

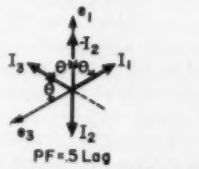
Metering:
Watts on 3 phase 4 wire
Transformers:
2 potential, 3 current trans.
Instrument:
3-current, 2-potential watt-meter
Special Features:
None
Limitations:
Balanced voltages (bal. error small) Standard connection
Cal. Watts =
Scale in watts
P.T. ratio x C.T. ratio x 4



VECTOR DIAGRAMS



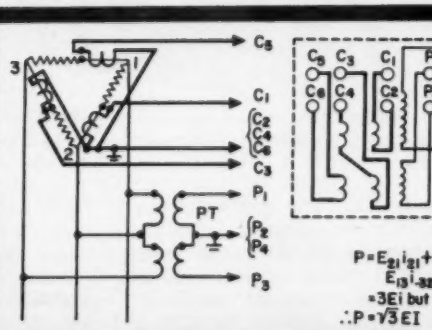
PF=1.0
$P=e_1I_1+e_3I_3+e_1I_{-2}\cos 60°+e_3I_{-2}\cos 60°$
$=e_1I_1+e_3I_3+.5e_1I_{-2}+.5e_3I_{-2}$
$=3eI$



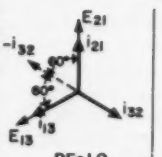
PF=.5 Lag
$P=e_1I_1\cos 60°+e_3I_3\cos 60°+e_1I_{-2}-e_3I_{-2}\cos 60°$
$=.5e_1I_1+.5e_3I_3+e_1I_{-2}-.5e_3I_{-2}$
$=1.5eI$

22

Metering:
Watts on 3 phase 3 wire delta
Transformers:
2 potential transformers
3 current transformers inside delta
Instrument:
3-current, 2-potential watt-meter
Special Features:
None
Limitations:
Balanced voltages (bal. error small)
Cal. Watts =
Scale in watts
P.T. ratio x C.T. ratio x 4



VECTOR DIAGRRAMS



PF=1.0
$P=E_{21}i_{21}+E_{21}i_{-32}\cos 60°+E_{13}i_{13}+E_{13}i_{-32}\cos 60°$
$=3Ei$ but i(Phase Current)$=\sqrt{3}/3I$
$\therefore P=\sqrt{3}EI$

PF=.5 Lag
$P=E_{21}i_{21}\cos 60°+E_{21}i_{-32}+E_{13}i_{13}\cos 60°-E_{13}i_{-32}\cos 60°$
$=1.5Ei$ or $\sqrt{3}/2EI$

MOUTH-TO-MOUTH RESUSCITATION THE NO. 1 METHOD

EXPLAINED BY WILLIAM C. BREMNER, SUPT OF SAFETY, COMMONWEALTH EDISON CO

And Elisha went up and lay upon the child, and put his mouth upon his mouth . . . and the flesh of the child waxed warm.

THIS PASSAGE from verse 34, chapter 4 of II Kings is one of the earliest historical records of the saving of human life by artificial respiration. However, this method seems to have been lost in antiquity.

In the fourth century A.D. attempts were made to restore breathing in a person by flogging. Because there is a similarity between death and sleeping, the people of that time believed that they might "wake up" the dead man by slapping, shaking, or whipping him; or by placing live coals upon his body. They also made loud noises, yelled and cried, or begged him to "wake up."

One ingenious development occurred when a resourceful individual reasoned that the use of bellows would blow air in and suck it out. There were several disadvantages of this method, the main one being that the bellows probably would not be available when the need arose.

By 1900, many other methods had been tried: hanging the victim upside down, rolling him over a barrel, or placing him across a saddle (stomach down) and trotting the horse. In fact, there have been over 100 recorded methods of resuscitation, ranging from the ridiculous to those based on scientific principles and medical experimentation. Most of them would keep the rescuer busy until the mourners arrived, but their effect on the victim was usually nil!

Bellows method of old was impractical and almost useless. Attempts to revive the victim by flogging kept the would-be rescuers busy until the mourners arrived

By 1903, Dr. Edward Schafer, on behalf of the Royal Medical Society of London, had conducted experiments which led to the development of the back-pressure or Schafer method of artificial respiration. This method, which has been used with

reasonable success in this country for years, consists of placing the victim in a prone position and pushing on his chest to force air outward. It relies on the elasticity or "spring" of the ribs for drawing air back into the lungs.

In the early 1930's, this method was improved upon by the addition of an "inhalation" phase, accomplished through enlargement of the chest by raising of the arms. This back-pressure arm-lift technique was more effective, and it received wide publicity and almost universal adoption.

In all of these methods, however, one vital fact was overlooked: the throat passageway must be kept open. What many persons do not realize is that the tongue is a rather large object, completely filling the lower part of the jaw. The portion we see move is only a small fraction of the entire tongue; and when unconsciousness occurs, the tongue flops back into the throat and blocks the air passage.

In the research and experiments carried on in developing the prone-pressure and back-pressure arm-lift methods, a trachea tube or airway was used so that a measuring device could easily be attached to determine the amount of air being moved during the inhalation-expiration cycles. The trachea tube assured a good air passage, but in normal rescue work this device is not available.

The mouth-to-mouth method (the steps of which are listed, right) has been approved by the American Red Cross, American Medical Association, Armed Forces, and many other nationally recognized authorities. It was accepted as the preferred method by the Accident Prevention Committee of the Edison Electric Institute at its Los Angeles meeting in July, 1959, and has since been adopted by many electric utilities for use on linemen and others, following electric shock.

There is sufficient oxygen in your exhaled air to keep another person alive. If physical contact is repugnant, a handkerchief (one layer) may be placed on the victim's face. This will not appreciably affect the flow of air.

There are a number of plastic mouth pieces on the market of the mouth-to-mask type, the use of which makes it possible for the rescuer to work without having to put his mouth directly on the victim's mouth or nose. However, such devices may very well not be immediately available when a crisis arises; or if available, they may have deteriorated from age or improper storage. In our company, we have taken the attitude that we must be able to perform mouth-to-mouth or mouth-to-nose resuscitation without depending on any device or gadget.

Start immediately, seconds count. Statistics show that the likelihood of successful resuscitation decreases very rapidly following cessation of breathing by the victim. Thus, there are good possibilities for success if resuscitation is started after a few seconds, but practically no chance of recovery after a four-minute delay.

This method does not eliminate the necessity for sending someone for a doctor, loosening the victim's clothing, keeping him warm, etc.

Resuscitation should be continued until 1. the victim revives, 2. a qualified person pronounces him dead, 3. rigor mortis sets in. There are cases on record where a victim has revived after several hours, so don't give up!

Last year, Commonwealth Edison Co showed the movie "Rescue Breathing" to all employees. This movie demonstrates the mouth-to-mouth technique and explains its advantages. The company also distributed to each employee a wallet card listing the essential steps, and has posted signs in certain areas as a reminder of the correct procedure to be followed.

Although no emergency among employees has arisen in the last year where mouth-to-mouth resuscitation has been required, several cases have occurred in their families. In each situation, the employee (or his wife) successfully revived a child.

Many times the comment is made, "I'd be willing to do this on my own family or friends, but not on so-and-so." The so-and-so mentioned is usually one of a different race, color, or social standing. However, the person making the statement has made one assumption — that *he* is the rescuer. Would *you* care *who* rescued you if you were the victim? END

Recent studies by Dr. Safar in Baltimore and Dr. Elam in Buffalo, along with others, have resulted in a new, more effective technique called mouth-to-mouth (or mouth-to-nose) resuscitation. The seven steps involved are given here:

1. TILT HEAD BACK. When possible, lay victim on his back with his head back, chin up. A rolled-up coat or other object placed under his shoulders will help to accomplish this.

2. RAISE JAW. Insert thumb between victim's teeth, grasp his lower jaw and pull up and out. When a victim's teeth are clenched, or his mouth is small (as in the case of a baby), place fingers at angle of jaw bone (about an inch below ears) and raise jaw up.

3. PINCH NOSE. Close victim's nostrils as shown in the sketch.

4. COVER MOUTH. Place mouth over victim's mouth, making an airtight contact, as shown in the sketch.

Note: On a baby, it may be necessary to omit step 3 and place mouth over the mouth *and* nose of the child.

5. BLOW AIR. Exhale your own breath until the victim's chest rises.

6. REMOVE MOUTH. Allow victim to exhale. If there is no sign of air movement, check for obstructions (tobacco, chewing gum, phlegm, etc), reposition the head, be sure the jaw is out.

7. REPEAT STEPS 5 AND 6. Repeat the blowing cycle 8 to 10 times rapidly, then at the rate of 12 times per minute for adults, 20 times per minute for children. If you find you are getting slightly dizzy or light-headed, slow up a little. (These figures are not critical. Variations brought on by excitement of the rescuer, distractions, deliberate slowing up, etc, will not diminish the effectiveness.)

ONE PRIME CONTRACT— ONE 350-MW PLANT INSTALLED

H. R. DREW, DIRECTOR OF RESEARCH, TEXAS ELECTRIC SERVICE CO,

DESCRIBES TURNKEY CONTRACT FOR NEW HANDLEY PLANT UNIT

LAST NOVEMBER, the award of a "turnkey" contract for a 350,000-kw steam electric generating plant, to be constructed as an addition to the existing Handley Plant in Fort Worth, was announced by Texas Electric Service Company. The new plant will be designed, furnished and erected, complete in all respects, by the prime contractor, Westinghouse Electric Corporation, including the demolition and removal of existing structures at the site. Completion date is May 1, 1963, but the purchaser has the option of delaying the completion date to December 1.

The new Handley Plant represents the culmination of an exhaustive investigation by Texas Electric Service Co of the benefits to be gained from a turnkey contract for a major power plant. It should be stressed at the outset that the successful pursuance of these studies and the ultimate realization of the contract could not have been possible without the cooperation of three of the country's major manufacturers who, in coöperation with three well-known power plant design and construction engineers, worked closely with the company and its engineers in the developmental phases of the project.

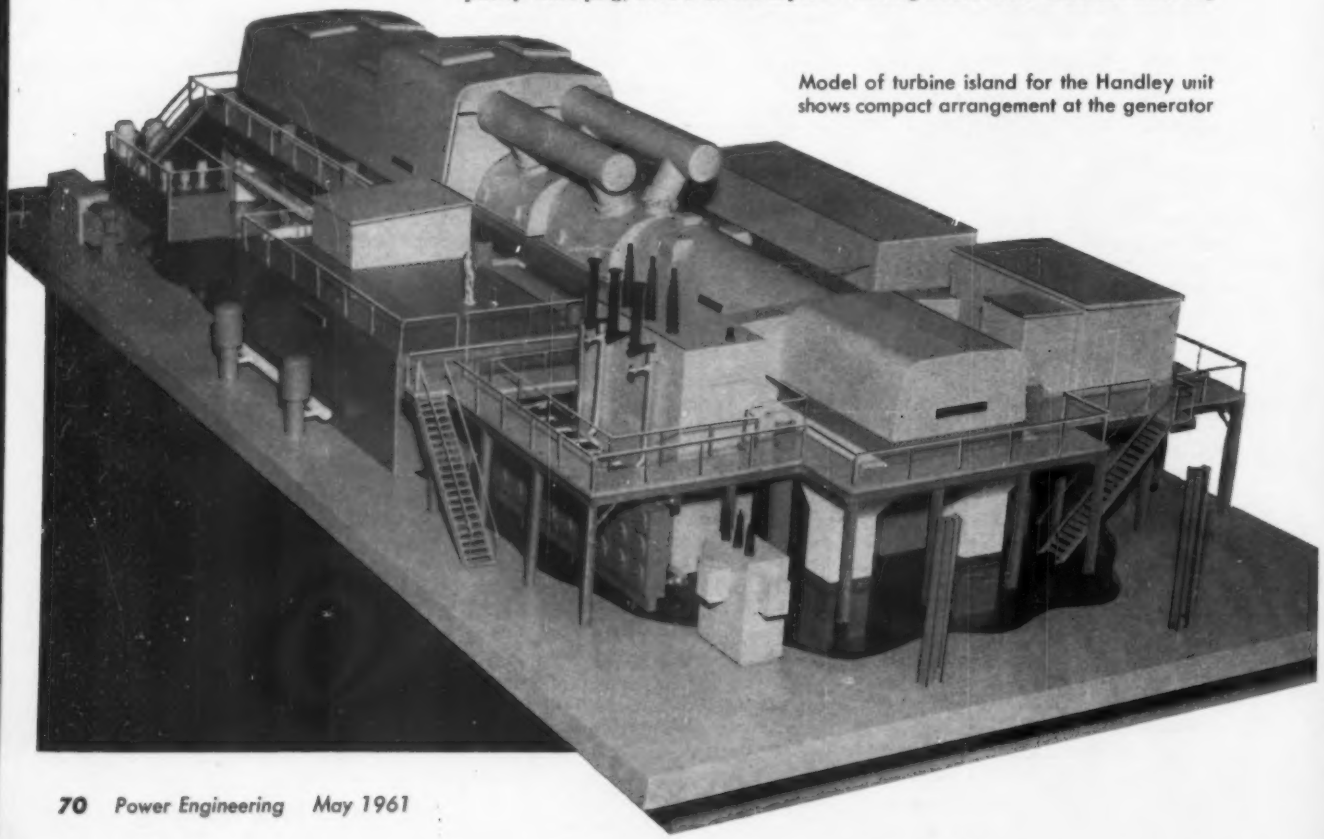
The Handley turbine generator will be a tandem compound, four-flow unit capable of delivering 350 Mw with throttle steam at 2400 psig 1000 F, reheated to 1000 F with all seven extraction heaters in service and with 3½ inches back-pressure and 95 F cooling water. A somewhat higher peaking capability is expected. The generator will be rated at 460 Mva 0.80 power factor and 0.64 short circuit ratio at 45 psig hydrogen pressure.

The boiler will be an outdoor, pressurized-furnace type designed for 2,486,000 lb per hr continuous capacity 2465 psig, 1005 F at the superheater outlet and to reheat 2,198,000 lb per hr from 536 psig, 632 F to 1005 F. The boiler will be designed for natural gas or standby fuel oil firing, with provision being made for future conversion to solid fuel.

A full capacity boiler feed pump will be driven from the turbine end of the turbine shaft through a hydraulic coupling. The heat cycle will include four low-pressure and three high-pressure heaters, the high-pressure heaters being by-passed as a group and the low-pressure heaters in two separate rate groups.

One main power transformer will step up from generator voltage to 138-kv system voltage with four taps. This transformer will have a 4 kv 20 Mva winding for station auxiliaries, and starting supply will be furnished from a separate standby auxiliary transformer.

The idea of a turnkey contract actually developed out of studies having a somewhat different aim: the



Model of turbine island for the Handley unit shows compact arrangement at the generator

esign of a large but compact unit in which savings were to be accomplished through re-design and/or relocation of major plant components. Our approach was to question every item of plant design to see what could be done to reduce its cost or even to eliminate it entirely. Out of this grew the concept of a "turbine island" and a "boiler island," each compact and efficient and designed for economy.

It became obvious that the concept of unified responsibility for the integrated design and construction of the plant offered the best avenue towards our goal. It seemed quite logical to adopt the "systems" concept, which has been so successfully utilized in the aircraft and weapons manufacturing industries, to the field of power plant design. Our studies and the final outcome of the bidding have shown that under this concept of manufacturer responsibility, real incentives exist to lead the manufacturer to produce the most efficient and economical design.

Accordingly, in January of 1960, manufacturers were invited to bid on a complete turbine or boiler island or both. Each turbine manufacturer engaged the assistance of a nationally known consulting engineering firm, and when the bids were in, two manufacturers offered to take full responsibility for the complete unit. The third bid on the turbine island only. The contract was awarded to Westinghouse, whose engineers are United Engineers and Constructors, Inc, at a total amount of less than $80 per kw on the 350,000-kw rating.

A general attention to location of equipment for compactness has produced a plant with a minimum of piping, valving and wiring. The boiler is located close to the turbine generating unit, with its water handling and fuel burning equipment unitized, and the extraction heaters are placed on or directly attached to the condenser. The low-pressure turbine assembly, a flash evaporator for purifying make-up water, and the two lowest stage heaters are in a common shell.

Other Practical Placements

The main generator leads come out the side of the generator and connect directly to matching bushings in the closely set main power transformer. The inclusion of the auxiliary transformer in the same tank with the main power transformer makes for lower costs. Many of the electrical controls are located on or immediately at the generator support structure, and the control room and its data logging unit are advantageously located immediately at the turbine support structure.

A single main boiler feed pump is driven through a hydraulic coupling from a shaft extension at the steam end of the turbine, and a smaller (30 per cent capacity) starting and emergency feed pump is nearby. This location of the boiler feed pump along with the compact placing of the extraction heaters has made possible a greatly simplified piping and valving system.

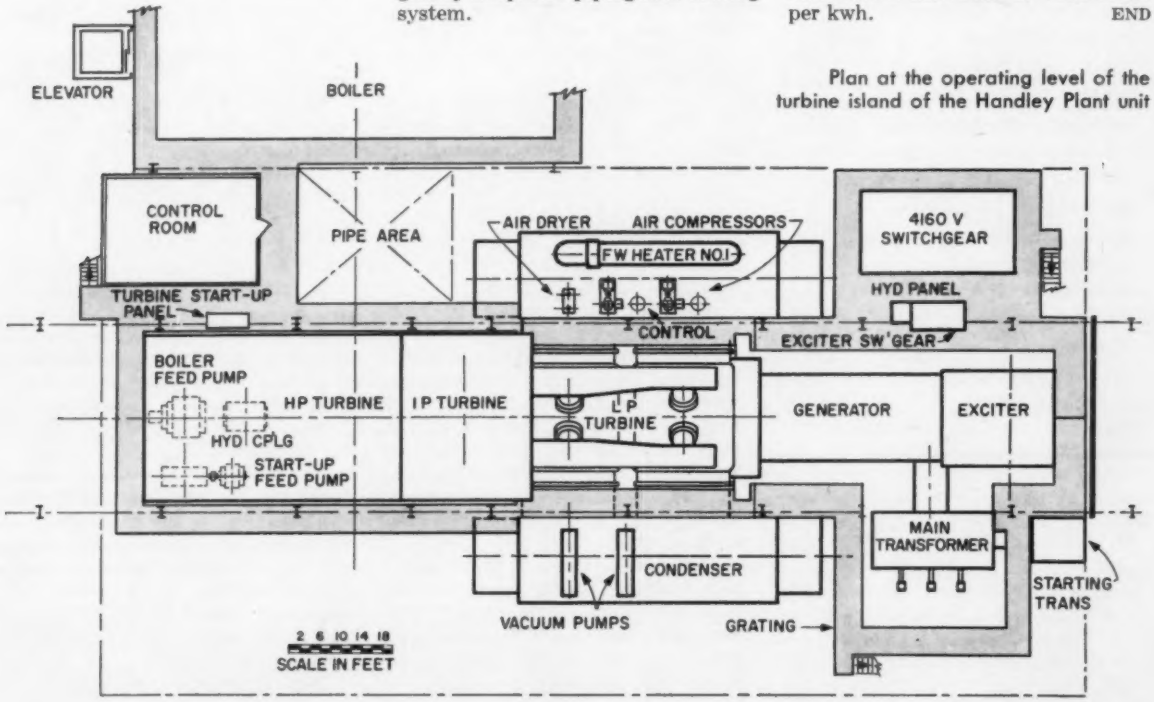
The substantial regrouping of turbine and auxiliary units also makes it possible for a much greater part of the turbine-generator assembly to be made on a factory floor and fitted for much quicker assembly in the field. The outdoor construction, although not a new concept in this area, is also responsible for savings in plant cost, as is the use of a low set, twin side outlet condenser arrangement with a gantry crane.

The control system will include a monitor and results computer capable of scanning 200 plant variables, logging and scanning 100 additional plant variables, and rating on command the performance of the plant and of each major component in the heat cycle.

Provision will be made in the design of instrumentation and control so that future conversion to fully automatic computer operation can be made by the addition of equipment, with a minimum replacement of existing equipment and controls and with minimum outage time.

Looking beyond the immediate benefits of unitized design, we think that additional savings can be had through repetitive manufacture of similar units. Manufacturers should be able to achieve substantial savings in engineering costs, material, and equipment purchases and time and labor costs by repeating a successful design. Thus the benefits from standardized designs could accrue to both utilities and manufacturers alike.

Editor's note: Heat balance diagram indicates a heat rate of 7892 Btu's per kwh. END



Plan at the operating level of the turbine island of the Handley Plant unit

PROTECT COOLING TOWER LUMBER WITH PRESERVATIVES

R. M. ATCHLEY, CHIEF CHEMIST OF ARKANSAS POWER & LIGHT COMPANY, DESCRIBES DOUBLE-DIFFUSION TREATMENT FOR EXISTING TOWERS

R. M. ATCHLEY

Mr. Atchley (shown above cutting wood samples into slivers) has supervision of water treatment and related processes in three generating stations. His wood preservation program has given him unusually extensive experience in this subject. He is a member of the American Chemical Society and has presented a paper on "Controlling Deterioration of Cooling Tower Lumber" before that organization.

DECAY OF LUMBER is now a recognized problem in cooling towers. Reports of early failure of redwood in cooling towers began to be heard in 1948. It is not known if prior failures went unreported or if the rate of failure had increased to a point where it became noticeable at that time.

Resistance to decay is caused by toxic materials contained in the wood that provide protection against wood-destroying fungi that cause decay. This material is water soluble; therefore it will leach out of the cooling tower lumber gradually until, after the tower has been in operation for from one to two years, most of this material will be gone. We know now that this material can be replaced by other materials that are less soluble in water and more toxic to wood-destroying fungi.

The Arkansas Power & Light Company operates three steam generating stations that use cooling towers for condensing purposes. Wood deterioration has occurred at all of the plants, and our experimental work at Cecil Lynch station has provided valuable data regarding the effectiveness of wood preservatives.

All of our towers were built of untreated redwood. Tower No. 1 at Lynch Station went into operation in 1947 and began showing evidence of severe deterioration after less than five years of service. Samples of wood from the tower were sent to the U.S. Forest Products Laboratory at Madison, Wisconsin, where it was determined that wood-destroying fungi were involved.

Decay was not a new problem to a public utility. That problem had been successfully solved by preservative treatment that is now universally applied to poles. It was logical to assume that preservatives would be beneficial to cooling tower lumber.

We were also faced with another problem. Preservatives are usually applied by pressure treatment, so they could be used to treat lumber for future installations, but offered no practical means of protecting an existing cooling tower. Investigation disclosed that the Forest Products Laboratory had developed a double-diffusion process by which green fence posts might be treated on the farm. Freshly cut posts were successively immersed in two solutions. The dissolved chemicals from each solution would diffuse into the moisture in the pole. The chemicals were selected so that they would react within the wood to form insoluble precipitates that were toxic to the wood-destroying fungi.

Wood in a cooling tower becomes water-logged, so diffusion treatment of cooling tower lumber was possible. After many laboratory experimentations and chemical analyses of wood, it was evident that the experimental treatment resulted in a satisfactory retention of preservatives. The effectiveness of the treatment in protecting the lumber against decay, however, would not become known for many years. This type of treatment seemed to offer the only possible solution to our problem, so we decided to treat half of one cell of Tower No. 1. This would provide a means of comparing treated and untreated wood in the same tower.

Inspection of the tower showed that white pocket rot was not present in the lumber of the tower, but that what has since been designated as soft-rot was present throughout the flooded sections of the tower. This type had weakened the eliminators and filling to the extent that the supports were beginning to collapse. Minor repairs were made to prevent

Atchley and J. W. Anderson, asst. plant supt., inspect 8-yr-old treated section

collapse of the filling, and half of one cell was given an experimental treatment in September, 1952.

Treatment consisted of successively applying two concentrated solutions of chemicals. The first solution consisted of a 6-to-1 ratio of zinc sulphate and arsenic acid. This was followed by a solution of sodium chromate. Sufficient chemicals were applied to give a retention of one pound of insoluble precipitate per cubic foot of lumber. Because of the experimental nature of the project, a large number of samples of wood from the towers have been analyzed to determine chemical retention. Such samples have been taken every six months and the results are shown in the tabulation below.

Minor repairs that were made prior to treatment proved to be satisfactory in the treated portion of the tower. That section has now been in operation an additional eight years since the treatment and the condition of the wood is as good now as it was then (see photo). It was apparent within a few months, however, that the attack was progressing in the balance of the tower. Major repairs were necessary within a year throughout the untreated section of the tower.

Tower No. 2 went into operation in 1949, so it is two years younger than Tower No. 1. By 1953, Tower No. 2 had white pocket rot and soft-rot and was in worse condition than the untreated portion of Tower No. 1. Extensive repairs were made, and a double-diffusion treatment was applied in 1954 to Tower No. 2 and to the balance of Tower No. 1.

Tower No. 1 has now operated six years more with only minor repairs being required. It now appears evident that major repairs could have been avoided if the entire tower had been treated in 1952.

Tower No. 3 went into service in 1954 and was treated two years later, before it had developed any signs of attack. A tower at another plant the same age as Tower No. 3 was also treated before showing infection. All other towers in the system had been repaired and treated by 1956. All of the 72 cells in our system have now been treated by double-diffusion.

Our results at Lynch Station are typical of what has happened at the other plants. Tower No. 3 is now six years old and was treated after two years of operation but before becoming infected. No decay has been found in the tower and the lumber is still in excellent condition. The original saw marks are still visible on the filling. This is a decided contrast to the two older towers, both of which had developed serious decay before they had attained the present age of Tower No. 3.

Treatment has stopped the advance of soft-rot in all of the towers, but white pocket rot has continued to advance in the non-flooded sections of Tower No. 2. The tower is now eleven years old, and it has been necessary to replace a small portion of the structural lumber during the last few years. We are convinced, however, that the repairs made would have been greater if the treatment had not been applied.

We have used shock treatment of chlorine once every eight hours to one ppm of free chlorine, sample taken just after the condenser. This keeps our condenser tubes free of slime and has no bad effects on the treatment of cooling tower lumber.

Use of pressure-treated redwood will increase the cost of a new tower by about eight per cent. The increased cost over untreated redwood will be about three per cent if the tower is built of treated fir, hemlock, or pine. These alternate species of lumber are reported to be quite satisfactory by other users. We have been using some treated pine for tower repairs in dry and non-flooded sections of towers and the results are good.

We applied the diffusion treatment to our first three towers with company labor. The remainder of the towers were treated on a contract basis by the tower manufacturer that pioneered this type of treatment. Cost of the treatment has been about the same for all towers except for the first experimental treatment, which was much higher because of the experimental nature of the work. With no price advantage for doing the work ourselves, we find it more satisfactory to have the treatment applied on a contract basis.

Cost of treatment varies considerably with the size of the tower, the unit cost decreasing as the size of the tower increases. The cost of treating an average size industrial tower is about five per cent of the original cost of the tower. The most economical way to buy a tower is probably to use untreated redwood and apply a diffusion treatment not later than two years after the tower goes into operation. Many towers are now being bought on that basis, with the cost of the treatment included in the purchase price. END

Samples of Tower Wood Determined Chemical Retention

TIME (After Treatment)	MAXIMUM	MINIMUM	AVERAGE
When treated	1.1808	0.4272	0.8040
Six months	0.9168	0.4893	0.7030
One year	0.9168	0.4792	0.6980
One year and 10 months	0.9099	0.4590	0.6844
Two and one-half years	0.8974	0.4340	0.6707
Three years	0.7789	0.4476	0.6133
Three and one-half years	0.6752	0.4100	0.5426
Four years	0.6683	0.4210	0.5447
Four and one-half years	0.6411	0.4506	0.5459
Five years	0.6219	0.4326	0.5273
Five and one-half years	0.6104	0.3925	0.5095
Six years	0.5992	0.4178	0.4985
Six and one-half years	0.5506	0.4067	0.4772
Seven years	0.5498	0.4029	0.4764
Seven and one-half years *	0.5217	0.3885	0.4551

* Samples now being analyzed after 8 years, but results not yet available.

AUTOMATED PRECIPITATORS FOR BIG STEEL PLANT

MAGNETIC CONTROL AND ANALOG INFORMATION SYSTEMS ARE THE KEYSTONES OF A NEW OPEN-HEARTH AIR POLLUTION CONTROL INSTALLATION AT THE PITTSBURGH WORKS OF JONES & LAUGHLIN STEEL CORPORATION

JONES & LAUGHLIN, cooperating with Allegheny County's air pollution control program, is installing electrostatic precipitators manufactured by Koppers Company, Inc, on eleven open-hearth furnaces. Hagan PowrMag magnetic controls and a Hagan AIM (Alarm Indicating Monitor) will play important roles in the over-all automation of the eight precipitators and the eleven waste heat boilers that cool furnace gases ahead of the precipitators.

Early planning for the job envisioned a control panel at each boiler and precipitator. However, when operating and supervisory requirements were spelled out, the thinking quickly evolved towards complete "centralization" of control. Thus, the solid-state control systems will reach out from a single 40-foot control house to control equipment spread out over an open-hearth shop more than ¼-mile long.

The AIM (the steel industry's first, for this purpose) will provide alarm and indication if any of 220 critical flows, temperatures, pressures or levels get out-of-limits. Thus, the operator in the central control house has continuous, automatic supervision of the entire system.

Graphic Indication

A graphic control panel will present clear operating information at all times, and further centralize the operation of the coördinated systems.

J & L will obtain these benefits from the system — benefits that were taken into account when justifying the initial investment:

1. Effective control of troublesome open-hearth dust.
2. Bonus steam .rom the waste heat boilers.
3. Most important of all, intelligent automation of the process to minimize operating costs.

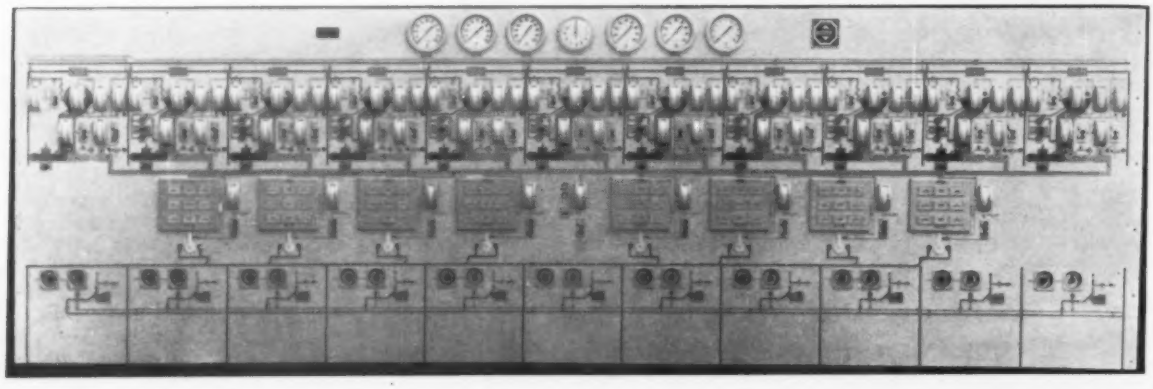
Steam will be produced in the waste heat boilers at a temperature and pressure that will permit its utilization in the powerhouse and blast-furnace blower house located on the other side of the Monongahela River from the open-hearth shop. Lower pressure steam, presently available for fuel atomization in the open-hearth furnaces, will drive the waste heat boiler feed pumps and induced-draft fans.

Solid-state systems will control boiler drum levels, flue gas system draft, precipitator paralleling, feedwater pressure, and feed pump recirculation.

One waste heat boiler and precipitator combination was installed and put into operation on No. 41 furnace in 1959 to gain experience. Operation of this facility revealed a number of refinements which are incorporated in the complete layout.

New waste heat boiler and precipi-

Fig. 1. Pictured below is the twenty-three-foot panel which is a main part of the control system for the eleven waste heat boilers. A feature of this control board is the clear presentation of operating information in unmistakable graphic form



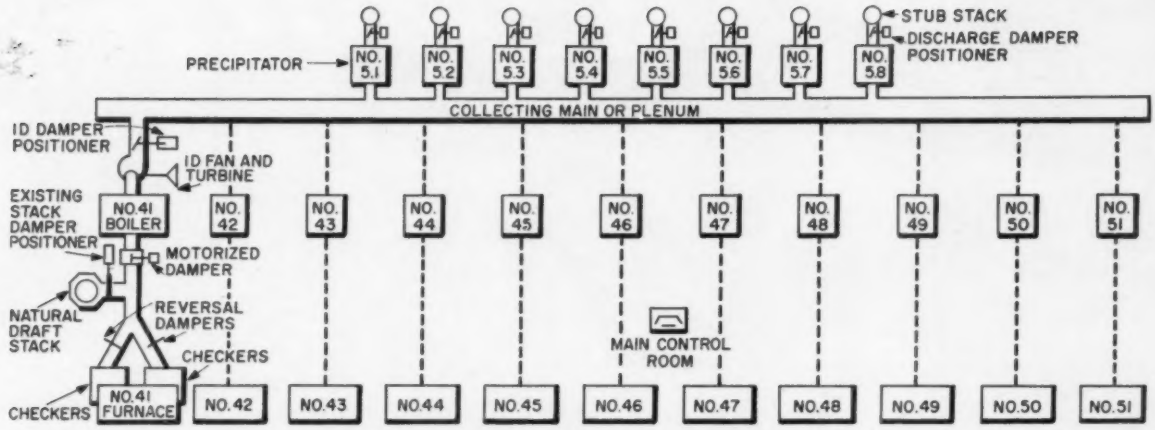


Fig. 2. Schematic diagram of the plant shows relative location of the eleven open-hearth furnaces and the main control room. All of the systems throughout the quarter-mile open-hearth shop are operated from the central 40-ft control room

tator control is tied into the existing furnace control and electrically interlocked to provide safety of operation. Since the eleven waste heat boilers are all under the supervision of the watch engineers, provision is made to direct hot flue gases from the open hearth to existing natural-draft stacks in the event of operating difficulties. This will prevent interference with steel production while the operating difficulties are being located.

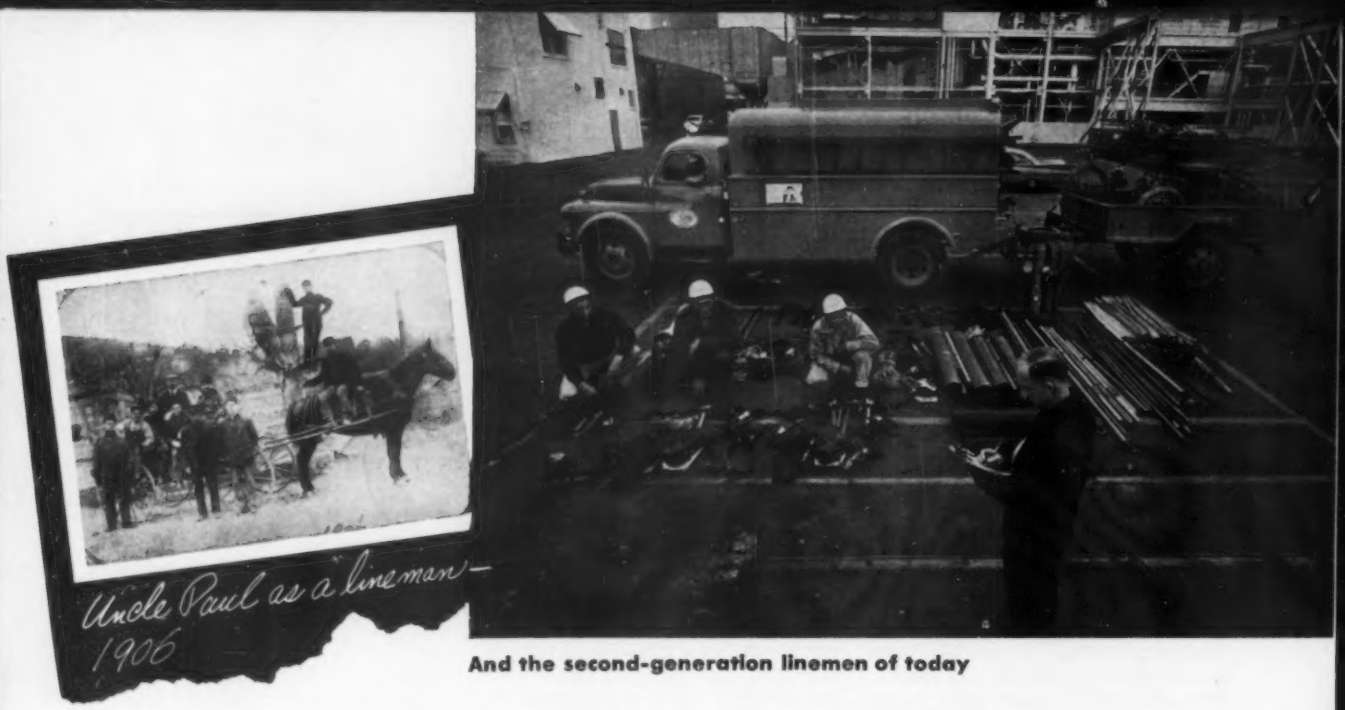
Provision is also made for sequential restoration of the boilers after outages. Gradual warm-up of the boiler and final transfer of draft control from the stack to the waste heat boiler and precipitators is accomplished in steps.

Fig. 3. Large extent of the plant is indicated in this photograph which shows an aerial view of the Pittsburgh Works of the Jones and Laughlin Steel Corp

Operation

A large plenum, or header, collects the gases from the open-hearth furnaces and discharges into the eight precipitators. Pressure in this plenum is controlled at a constant value by varying the rate of flow to the eight precipitators. The signal from the plenum pressure controller goes to eight collector flow controllers, acting as a common set point for all eight. These eight flow controllers in turn operate dampers on the discharge of each precipitator. This parallels the flow equally between all eight or any other operating number of precipitators.

Practically applied on this job, the "centralized control" concept is another example of the operation of all the control and measurement apparatus on a process from a central location. The growing acceptance of industrial centralized control stems from a number of considerations, including: ease of control from a central location, greater control accuracy from centrally available measurements, reduction of supervisory requirements, increased safety with all measurement and control indications at the fingertips, and faster plant-wide operation by the operators. END



And the second-generation linemen of today

LINE TRUCKS AND EQUIPMENT— THEN AND NOW

E. P. NANEY, OF INTERSTATE POWER COMPANY, COMPARES PRESENT UTILITY EQUIPMENT WITH THAT OF YEARS AGO

MODERN LINE TRUCKS are far removed in appearance and utility from the horse-drawn line crew conveyances used in the early part of the century. The tools on today's trucks have become more comprehensive in comparison with those carried on their predecessor horse-drawn vehicles. The list of tools carried on one of our district construction and maintenance line trucks illustrates the variation in types used to prosecute the work with efficiency, dispatch, and safety.

A close look at the tool and equipment list tells a story of a distinct change from the nostalgic past. First, the *truck* itself is a piece of mobile equipment which provides transportation for men, materials and tools. It also furnishes power take-off for digging, hoisting, and pulling attachments. On the trucks are many types of tools, and a short discussion of these gives an indication of work that can be handled.

Pole and anchor setting tools show only a token number of long-handled shovels and spoons and a minimum of pike poles, digging bars, and tamps. These, of course, have been replaced with power-digging and power-setting attachments. The variety of aluminum and copper conductors in use today requires a multitude of wire grips and splicing tools, but lever chain hoists and winch lines replace, to some extent, heavy rope blocks and tackle used formerly.

Power chain saws speed up the work of tree and brush control, and replace many of the axes, wedges and sledges. The hazards of working on energized lines have practically been eliminated, or at least minimized, by development in the usefulness of rubber gloves, line hose, hoods and safety platforms. Line work still requires a lot of hole drilling, so the list of drills is large. Heading the list is an electric drill, in place of hand braces, breast drills and other hand methods.

Miscellaneous Tools

A list of the miscellaneous tools indicates the variable skills found in the modern line crew. A portable generator furnishes power for electric power drills as well as lighting for emergency night work. Red flags and flares are a necessity on heavy-traffic streets and highways. Also, some of the miscellaneous tools are an indication that there are still some back roads to be traveled, and snow drifts to be shoveled, during bad weather.

Some of the principal items carried on a modern line truck are these: Power winch, derrick and digger; chain saws, axes, ladders and trimmers; hot-line tools, safety hats, rubber goods, grounding lines; electric drills, wrenches, shovels, hand tools; portable generators, load-binders, chains; splicing tools, ropes, blocks, wire grips; take-up and pay-out reels; pole trailers and cable dollies; soldering outfits and test equipment.

Aerial towers, mounted on line trucks, have come into wide use today. Such equipment provides faster — and safer — work in the air, and keeps poles from being damaged by too much climbing. Recently, the American Electric Power Co announced a new technique of working lines hot, from an insulated boom, with bare hands. This new procedure should revolutionize line work, and make it almost mandatory that every truck be equipped accordingly.

Two photos show typical line "trucks" of 1906 and 1961; the earlier one came from our company archives, and the latter one was furnished through the courtesy of Florida Power and Light Co.

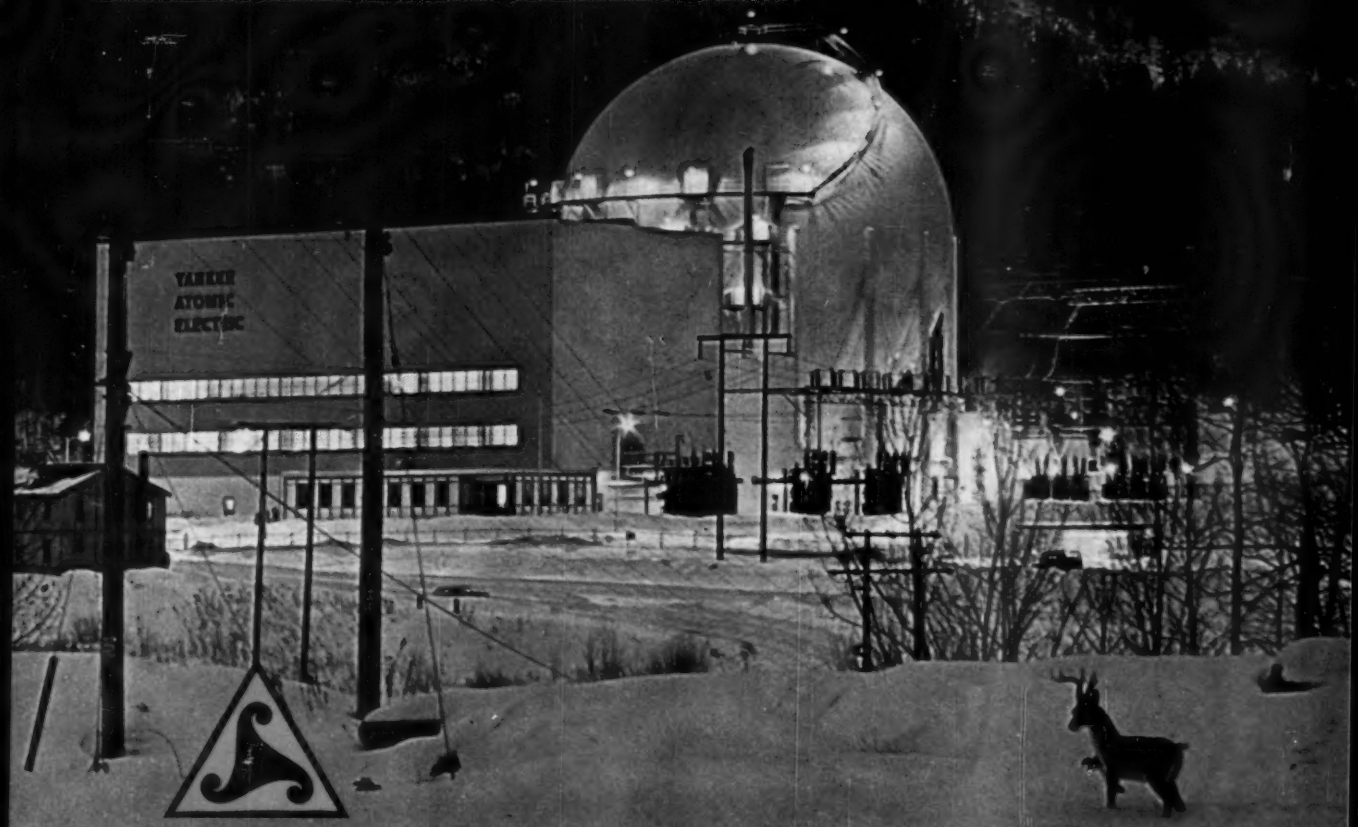
It is a great tribute to the men on utility line crews that they are proficient in the use of such a wide variety of tools and equipment. And, they use them well — and safely. END

vision

From the first successful chain reaction, the vision of nuclear power has attracted engineers capable of turning advanced theory into practical reality today. This same practical vision has characterized the men responsible for our nation's first commercial nuclear power stations.

Stone & Webster Engineering Corporation, in collaboration with Westinghouse Electric Corporation, designed the Yankee Atomic Electric Co. Power Plant at Rowe, Massachusetts. This nuclear plant constructed by Stone & Webster was completed within budget estimates. Capable of supplying some 3% of busy New England's power needs, Yankee's 136,000 kw capacity may well be exceeded and the plant itself is expected to prove an excellent long-term investment for the ten New England utilities that make up Yankee Atomic Electric Co.

As in the design and construction of steam and hydro power plants, Stone & Webster has made many major contributions in the development of commercial nuclear power. Let our broad experience help solve your next engineering problem.



STONE & WEBSTER ENGINEERING CORPORATION

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New York, 90 Broad St. Boston, 49 Federal St. Chicago Houston San Francisco Los Angeles Seattle Toronto Calgary

Power Engineering

HANDBOOK

Measuring the Elbows

By STAN CLARK

HERE'S A SIMPLE METHOD to determine the length in inches of an elbow to be cut and welded into a pipeline, or other project.

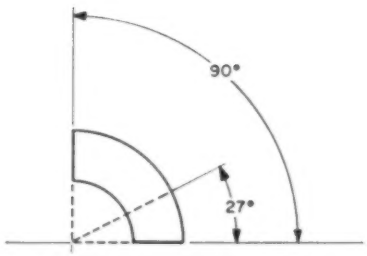
Measure the length of the 90-deg elbow along its greatest length. With this measurement and knowledge of what degree elbow you need, make the following calculations:

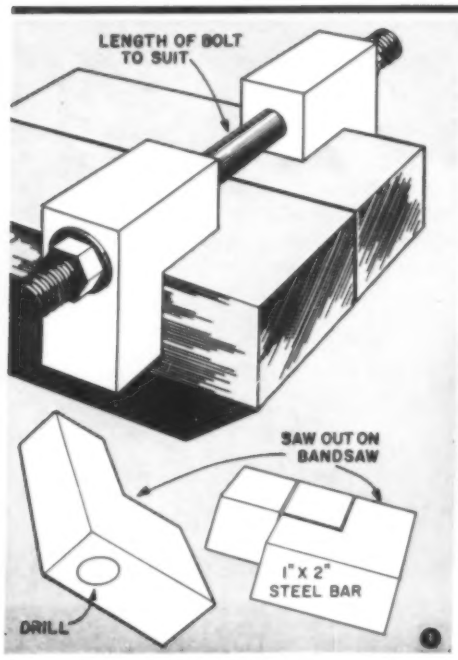
For example (8-in. elbow)

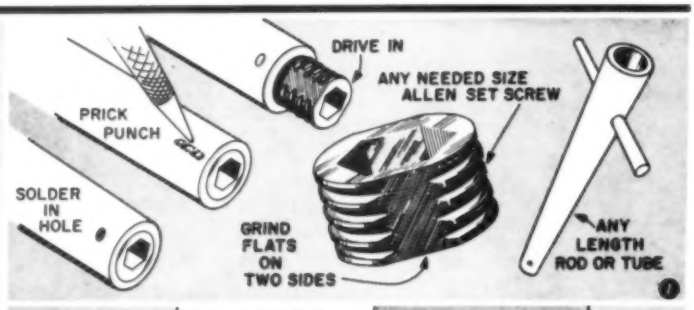
Length (measured) 19.375 in. 27 degrees (desired angle)

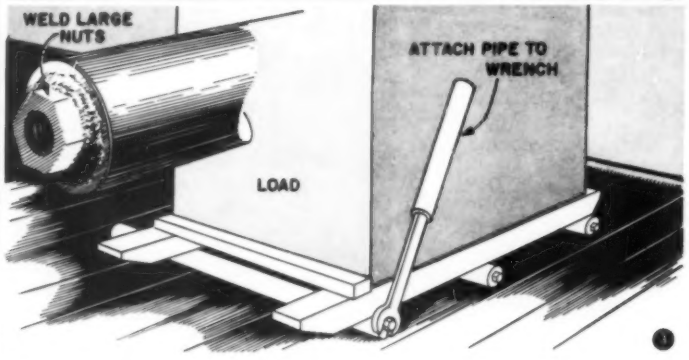
$$\frac{19.375}{90} \times \frac{27}{1} = \frac{58.125}{10} = 5.81 \text{ in.}$$

To obtain the length of the cut for the inside of the ell, simply measure its length and proceed as above. With these two lengths obtained, the cut can be marked and made.









More Shop Kinks

By CHARLES H. WILLEY

WE HAVE FOUND the shop-made clamp shown in Fig. 1 very handy for work of various kinds. Such a clamp is easy to make from flat bar stock. Squaring up the L-shaped pieces and drilling is all the machine work required; then any length of bolt needed can be made from threaded rod.

Figure 2 shows how to make a small size nut socket wrench that will reach deep into the work, using Allen hex socket set screws. Select the size of screw to fit the nut desired. Find a piece of tube (or rod) and drill a hole in the end the diameter of the set screw.

Next, grind a couple of flats on the sides of the screw. Drive the screw into the hole and secure it by denting in the metal of the rod onto the flats with a punch; or drill a small hole in the rod or tube in line with the flats and solder through the hole to secure it. Finish by adding a T-handle or round wood handle.

Figure 3 shows how welding large steel nuts to old shafts, and using a wrench (plain or ratchet), can make it easy for a couple of men to move heavy loads.

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Determining Fan Capacity for Coal Firing

By **SANFORD BENNETT,** assistant chief engineer, American Technical Co

THE ACCOMPANYING chart allows easy computation of the fan capacity required to furnish air for combustion of bituminous coal with any type of firing. Since the chart incorporates the usual calculation for excess-air requirements, it eliminates many tedious steps.

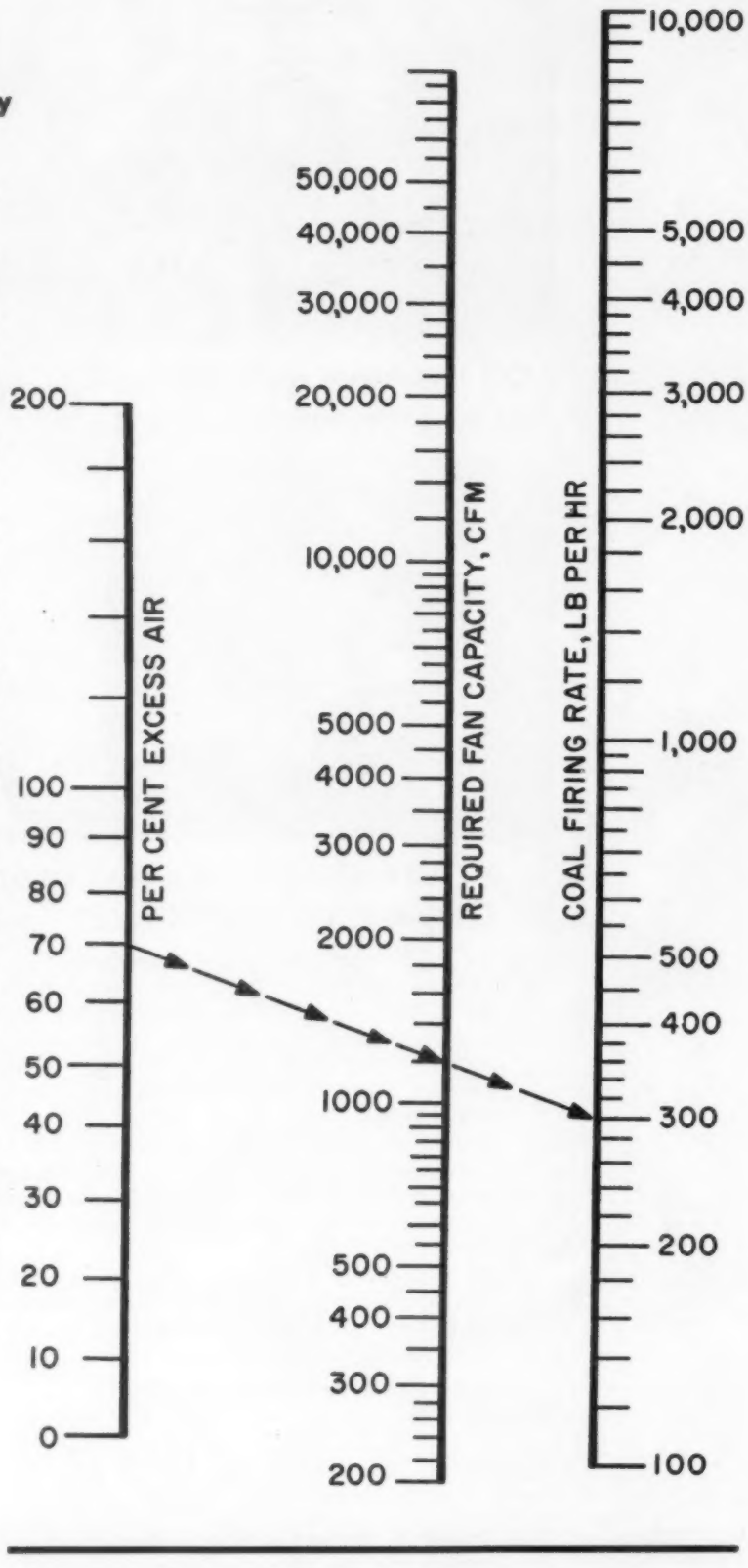
Example: What is the required combustion-air fan capacity for a furnace burning 300 pounds per hour of bituminous coal with 70 per cent excess air?

Solution: Enter the chart on the left at the per cent excess air, 70, and draw a straight line through the firing rate, 300 lb per hour, on the right. At the intersection with the central scale read the required capacity as 1200 cfm.

Fan capacity determined from the chart is the capacity required *before* any arbitrary additional rating is applied. Thus, if in the above example, a 20 per cent safety factor were to be applied to the capacity before choosing the fan rating, the rating would be 1200 + (0.20) (1200) = 1440 cfm.

If no excess air is used (theoretically perfect combustion), enter the chart at 0 per cent excess air. Where the firing rate exceeds the values plotted in the chart, move the decimal point one or more places to the *left* to obtain a plotted value before entering the chart. Solve as in the first example above. Move the decimal point the same number of places to the *right* in the result (required fan capacity).

This chart is based on C = AP, where C = fan capacity required at a given excess-air per cent, cubic feet per minute; A = combustion air required at a given excess-air per cent for bituminous coal of the analysis given below; P = coal firing rate, pounds per hour. In computing the air quantities the following coal analysis was used: higher heating value 14,000 Btu per lb; C = 78.0 per cent; N_2 = 1.4 per cent; O_2 = 7.0 per cent; H_2 = 5.5 per cent; Ash = 8.1 per cent.



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Continued from page 48

of combustion; sulfur dioxide is adsorbed from the gas stream by iron oxide to form sulfur trioxide, which reacts with alkalies and iron oxide to form complex sulfates. The complex sulfates, in a molten state, react with iron of the tube to cause wastage. Apparently none of the normally used coal properties including total alkali content is a measure of tendency to form corrosive deposits, *except* quantity and ratio of water-soluble alkalies, which appears to be a critical factor.

Water

Water problems in the power plant of U.S. Steel's South Works in Chicago have been dealt with in a practical and determined way, by modifying the old equipment now in use, at a fraction of replacement cost and getting modern acceptance levels of performance. Robert S. Walters described the methods used.

Boiler scale prevention with EDTA chelating agents was described by J. C. Edwards and E. A. Rozas of Dow Chemical Co. The method (using Versene 100) incorporates a complete removal, by blowdown, of the products of the internal treatment, rather than the usual deposition of at least a portion of the calcium and magnesium salts formed by phosphate treatment.

Speaking on the prevention of corrosion in steam systems under changing load conditions, Marcel Stein of Illinois Institute of Technology said that far more of the difficulties experienced in steam systems are due to shutdown corrosion than is generally acknowledged. Best means for preventing shutdown corrosion, Stein said, is to keep the steam system dry during shutdowns. No chemicals are required, and operating and maintenance costs are practically zero. The water treatment can be adjusted to operating period conditions only, and in the case of perfect deaeration at all load levels no additives are required.

Conductivity measurement of steam purity was the subject of a thorough presentation by R. W. Lane, C. H. Neff and T. E. Larson of the Illinois State Water Survey. They discussed the pH-conductivity relationship of the ammonia-carbon dioxide system at 25 C and 100 C; the increased sensitivity obtained by recording the conductivity measurement at 100 C; the conductivity of low concentrations of acids at 98.5 C; and application of this conductivity data to the calculation of the dissolved solids in carryover.

J. W. Strub of DuPont engineering service division reported that the chord or gradient thermocouple has, in their experience, been most effective in monitoring the thermal resistance of boiler water side deposits.

Flash evaporators are an advance in the treatment of make-up water suitable for high-pressure, low make-up, steam turbine plants. They minimize one of the main disadvantages of submerged tube evaporators — the considerable increase in heat rate. This was the conclusion of M. E. Gilwood and J. G. Mack of Pfaudler Permutit, who further stated that demineralizing appears more suitable on those waters having less than 500-ppm electrolytes.

First four years of demineralizer operation at Linden Generating Station of Public Service Electric and Gas Co were reviewed by R. I. Smith and H. D. Reppin. The 3200-gpm water treatment plant includes five stages: cation exchange, vacuum degasification, weak base anion exchange, strong base anion exchange, and mixed bed polishing units. A continuous supply of ultra-pure boiler make-up water from highly polluted surface water has been accomplished with a minimum of operating attendance (two men per shift).

Eugene Schmidt of L-A Water Conditioning, Inc, and Norbert W. Sager, chief steam plant engineer of the City of Burbank, Calif., presented a discussion of mixed bed demineralizers operated in series. A series mixed bed system is reported to be particularly favorable for low alkalinity waters where the value of intermediate carbon dioxide is relatively small. It is also advantageous for small systems where greater complexity cannot be justified and minimum operating attention is essential.

Operating experience with high flow rate condensate polishing equipment at Dresden Nuclear Power Station has produced results "at least as good as those obtained with systems employing filters and demineralizers." So reported A. B. Sisson of Commonwealth Edison Co, R. C. Reid of General Electric Co, and H. W. Frazer of Infilco, Inc.

The subject of sea water conversion was covered in two papers, one by R. E. Whistler of Southern California Edison Co and one by G. E. Sonderman of the consulting engineering firm of Singmaster & Breyer. Whistler described results of the first year of operation of the water distillation pilot plant at Mandalay Steam Station (see POWER ENGINEERING, April, 1961, page 52). Sonderman discussed economic aspects of the Mandalay plant, said:

Actually there are two aspects where the power industry is involved in the application of sea water conversion. One is the direct application of techniques for purifying unsuitable waters to make them usable for boiler feed for steam-electric utility stations. Then there are the broader interests such as load building from the increased use of home-type and small community-size desalting units, and participation in the water industry by the operation of large municipal salt water conversion plants.

Industrial Plants

In an interesting session on Industrial Power Plant Problems, George R. Chadwick, consulting engineer, explained how he helps conserve utilities in the small boiler plant. He follows the well-established practice of eliminating the small leaks and wastes, such as those from uninsulated pipe, leaky valves and pipe, and poor combustion in the boiler.

In one installation, converted from coal to oil, he utilized the stoker fan and a home-made air preheater to improve combustion and output of a boiler that he equipped with a water-wall extension furnace; that increased the efficiency from 65 per cent with the stoker to something over 80 per cent on oil burning.

Roland S. Grambau, Education Department, The Dow Chemical Co, related their experiences in instrument training programs. Their men attend classes four to six hours a week. They are taught by a full-time instructor with the proper background, their progress is evaluated, and all their maintenance training is done under contract agreements between the company and the union.

Walter W. Cartwright and Harry R. Blount of the NAPE outlined an adult education program for power plant personnel as carried out in Des Moines, Iowa.

In controlling the cost of electricity for industrial plants, Rolland H. Bradford of Ebasco Services advocated these methods: Get a utility representative to help check the rate, to be sure it is the best available, and is being billed correctly; check operations to be sure that you do not add to your peak demand; check motor loadings to insure operation at best efficiency and highest power factor; check circuits to be sure line losses are at a minimum; and check these things continuously.

An interesting paper was given by Perry Choncholos and William Kirstimon, of the Rehabilitation Institute of Chicago, on Training the Handicapped for Service in Industrial

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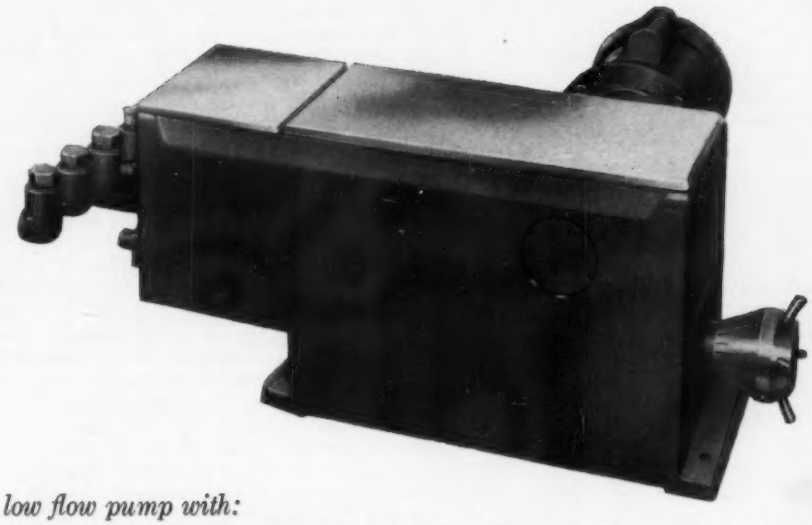
CONTROLLED VOLUME PUMP



The low flow pump with:
Totally enclosed, self-lubricated drive • Adjustable capacity while running

If you meter low flows, here's the most perfect pump on the market . . . at the right price. Its novel, totally-enclosed drive unit operates in oil—practically takes care of itself. And capacity of the MILROYAL can be easily adjusted while operating—manually or automatically.

The new MILROYAL has been developed as a direct result of your needs. And to meet this "ideal" in precise metering and pumping, Milton Roy introduces, with this pump, a unique drive unit which:

1. **Translates high speed rotary motion of the pump motor to low speed reciprocating motion with a minimum of working parts.**
2. **Lubricates itself. The entire unit is totally enclosed . . . all bearing surfaces continuously lubricated.**
3. **Provides 0-100% stroke adjustment while operating—with capacity adjustment a linear relationship. Metering accuracy is ±1.0% or better.**
4. **Adapts readily to either electric or pneumatic stroke control units for use in automatic control systems.**

MILROYAL pump capacities currently range from 0.89 gallons per hour (gph) for pressures up to 4,470 psi to 88.0 gph at pressures to 170 psi. As many as 9 MILROYAL pumps can be driven by a single motor. Present models utilize motors from ¼ to 1 hp, with larger motor units now in development. Either Step-Valve or Diaphragm liquid ends can be used.

Bulletin 258-1 describes in detail the operation of our new unique drive and what this means to you in more efficient, trouble-free operation. It lists all specifications for the "perfect" metering pump. Write for it.

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Plants. They discussed first the development of the rehabilitation concept, its nature and scope. In particular, they pointed out that handicapped individuals can work at certain jobs in power plants, and do.

Utility expenses in industry are service; but expenditures for these are frequently allocated by increasing the more obvious costs by a fixed percentage. This, said Myron B. Golber of Armour and Company, results in some incorrect methods of figuring industrial utility costs. He pointed out that proper allocation of utility costs should be done in two parts: the fixed, basic or non-variable portion that changes little except with time, and the variable or incremental portion of the expense that reasonably follows trends in plant production levels.

Factors to consider in the selection of diesel-electric generators for emergency power were discussed by E. A. Gibbons of Allis-Chalmers, who outlined the factors that must be considered, such as: analysis of the emergency loads in lights, motors, and other equipment that must be carried; effect of the largest motor on the system that must be operated in an emergency, and the possibility of starting that one first, with the smaller motors to follow, thus requiring less total emergency capacity; necessity for lights at vital spots or a continuation of certain processes that cannot be interrupted; and similar factors.

In a session on industrial and central station steam generators, the application of centrifugal compressors to soot blower systems was discussed by J. W. Locke and R. G. Thesing of Diamond Power Specialty Corporation. The authors first discussed the characteristics of centrifugal compressors and then showed how they could be applied to supply air for soot blowing systems in utility boilers. Location of the various types of retractable blowers, furnace wall slag blowers, and non-retractable blowers were shown for a typical boiler.

Flue Gas Sampling

Flue gas sampling and analysis for oxygen in cyclone-furnace-fired boilers at the Bridgeport Harbor Station was reported by F. C. Luxl of Leeds & Northrup and J. J. Osochowsky of United Illuminating. They reported work done on a 620,000-lb-per-hr, 1650-psig boiler at Bridgeport Harbor, fired by three cyclone furnaces side by side across the furnace front wall. After discussing the fundamentals of cyclone furnace combustion, the authors showed how they installed sampling probes. They discussed location of the probes and showed by charts how at various loads, with the recirculating gas fan on and off, the oxygen in the flue gas tested in the range of 2 to 3 per cent, under various conditions.

Commenting on this paper, L. G. Freidle of the Dow Chemical Co gave data on their experience in testing flue gas on boilers fired by two cyclones instead of three.

A paper on preventing furnace explosions and application of flame detectors was delivered by William L. Livingston and Phil Gray, Jr, of the Kreisinger Development Laboratory of Combustion Engineering, Inc. After reviewing the conditions that cause furnace explosions, Mr. Livingston showed that explosive furnace mixtures can result from improper sequences, insufficient ignition energy, and off-ratio firing. He discussed the various fuel-lean, fuel-rich, air-lean and air-rich mixtures that can occur; described what a proper control system would have to do for safe operation; and then demonstrated a very dramatic model of a furnace.

By varying the fuel and air supplies, shutting off the fuel and air in various combinations, the speaker was able to produce small furnace explosions or to prevent them by inerting the furnace. His conclusion is that only by inerting the furnace after it is shut down can we be sure that it is safe to start up again.

Peaking Symposiums

Two important symposiums were held on peaking, one covering hydroelectric plants for this purpose, the other, thermal plants. J. D. Howard of Wisconsin Power and Light Co outlined some of the problems and presented data based on the work of his company and his area on the Wisconsin River.

C. T. Wanzer, vice-president and chief engineer of Duke Power Co, discussed in detail the development of the Catawba River and its valley, carried out entirely by this investor-owned utility with private capital. In the period since 1904, 12 dams and hydroelectric plants have been constructed on the river, and the last one at Cowans Ford is now under construction and will complete the project.

The speaker outlined the operation of the system, which includes a number of steam plants, built originally for peaking capacity but now base load plants, thereby changing the original character of the hydroplant functions. The company has built steam plants of high efficiency for approximately $100 per kw, and existing major hydro plants at an average cost of $98 per kw.

Development and description of the Taum Sauk pumped-storage project was explained in detail by George P. Gamble of Union Electric Co. The same details were given in a two-part article by Mr. Gamble in the November and December, 1960, issues of POWER ENGINEERING.

The symposium on peaking by thermal methods began with a paper on Fundamentals Affecting Peaking Capability, by J. H. Euston of Business Research Corp and William A. Lewis of Illinois Institute of Technology. They discussed four factors: the load, the equipment and its location, the money market, and the public sector. They described a power supply model which shows on three axes the load structure in levels of different load factor or ranges of operating cost, the investment and cost structure, and the time. They pointed out that the principle of incremental costing can be used.

B. B. Brownell of Electro-Motive Division of General Motors Corp discussed the use of their package diesel plants by a large number of utilities for peaking, area backup, and spinning reserve on their systems. Many of these were described and illustrated in the special section on Power for Peaking in the October, 1960, issue of POWER ENGINEERING.

An evaluation of peaking in the 1960's with gas turbines was given by H. A. Carolson and W. D. Marsh of General Electric Co. Peaking gas turbines are now available in unit sizes from 10,000 to 30,000 kw. The authors outlined the same factors discussed in the Oct, 1960, section on Peaking Power. Since that time, several package peaking plants rated 11,250 kw have been ordered.

Air Pollution

Behavior of effluents from power plant stacks depends greatly on local topography. Illustrative examples of this were given by E. Wendell Hewson, Eugene W. Bierly, and Gerald C. Gill, all of the University of Michigan. They also reported results of a recent investigation of atmospheric diffusion near the site of the Enrico Fermi Atomic Power Plant.

Observations and experiences resulting from a precipitator improvement program were given by M. J. Archbold of Commonwealth Edison Co. Archbold rated most important design item for a precipitator as power to the electrodes. If sufficient power is available with automatic voltage control, fairly good performance can be obtained even though other items are not up to par. END

NEW *Nalprep**: KEY TO EFFECTIVE PRETREATMENT OF COOLING WATER SYSTEMS

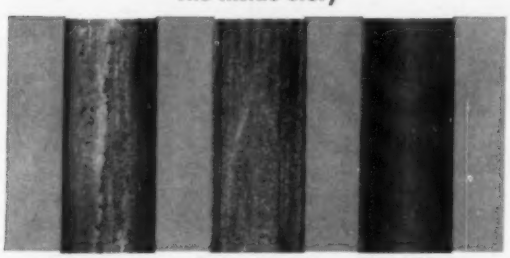
Triple-Action Treatment for Complete Preparation At Critical Points in Cooling System Life

Your experience can tell you at once that a newly-fabricated cooling system is never completely clean and free of oils, dirt, corrosion, and other contaminants . . . And that specifications calling for equipment "free of corrosion or corrosion products and thoroughly cleaned" are closer to wishful thinking than practical engineering. You know that a clean, fully-protected system will have fewer maintenance problems under the typically fluctuating conditions in a new system . . . but also that cleaning after the equipment has been in service destroys the protective film and exposes metal surfaces to rapid corrosion.

Now, with *Nalprep—and only with Nalprep*—cooling systems can be continuously, effectively, and economically protected from corrosion from the very start.

Nalprep performs three vital jobs at two critical times in the life of a cooling system. The times are: when the system is new; and immediately after cleaning. The jobs are: (1) removing organic and inorganic materials and deposits from metal surfaces, (2) preventing the clean, activated metal from reacting with anything but filming inhibitor, and (3) *at the same time* providing the initial protective film of corrosion inhibitor over the entire metal surface.

The Inside Story



No pretreatment **Degreasing only** **With *Nalprep* treatment**

Three identical mild steel exchanger tubes shown above received the same filming corrosion inhibitor dosages for one week. Tube at left shows rapid corrosion development when no pretreatment was given. Center tube was degreased only; shows beginnings of pitting and tuberculation. Tube at right received *Nalprep* treatment. Protective film is complete; corrosion non-existent.

Time lapses, varying from a few hours to days or even weeks, usually occur between the basic steps of construction, cleaning, testing and starting up cooling systems. These intervals expose metal surfaces to corrosion, so that when initial high-level filming inhibitor treatment is used at startup, without pretreatment, there are already corrosion sites in the system: areas which will not permit film formation to occur, regardless of the effectiveness or concentration of the inhibitor. This is why many properly-treated systems show disappointing, damaging corrosion-in-progress early in life.

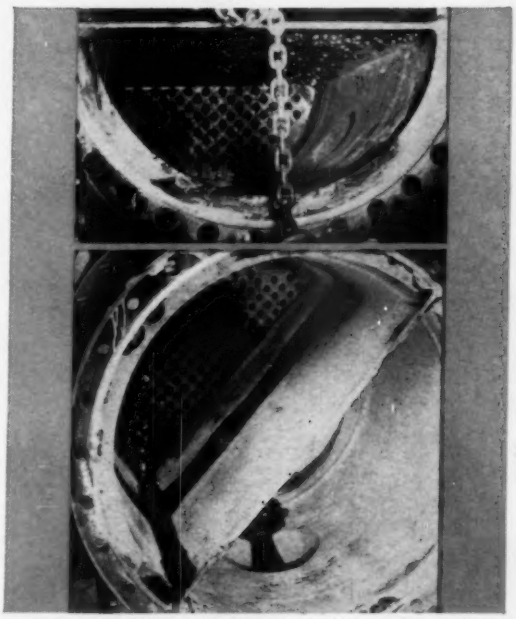
How *Nalprep* Works

Nalprep was developed to clean metal thoroughly, then protect it with corrosion inhibitor before it can react with anything else to begin forming corrosion sites. After initial *Nalprep* filming, and subsequent adequate maintenance dosages of inhibitor, corrosion need never be a problem again.

Fed to a new system in water—which ideally can be the water used for hydrotesting—*Nalprep* does a quick, complete job of cleaning and putting the initial film on all metal surfaces. Or *Nalprep* may be used to treat individual parts of a system, or to protect new equipment being added to an old system. After acid cleaning or mechanical cleaning, *Nalprep* can also be used for fast re-establishment of a tightly-adherent protective film.

It should be emphasized that high-level treatment alone is not a satisfactory substitute for *Nalprep* pretreatment.

Nalprep on the Job



Two new heat exchangers in the same cooling system are shown here after hydrotesting. New exchanger at top was not pretreated. Corrosion gained considerable headway during hydrotesting, as evidenced by the severe tuberculation visible on the baffle plate. Exchanger at bottom received *Nalprep* pretreatment. Note completely filmed baffle, tubes and sheet; absence of any corrosion residue.

Nalprep effectiveness, as illustrated above, leaves no doubt about the basic economy of including the *Nalprep* step in both new and cleaned cooling systems. Pretreatment, while adding little to overall time and cost, adds a great deal to subsequent savings in corrosion prevention, downtime and maintenance charges. Ask your Nalco Representative for details on *Nalprep*.

Nalco Technical Data Kit C4 tells the story of *Nalprep* development and results. Your copy free on request to Nalco.

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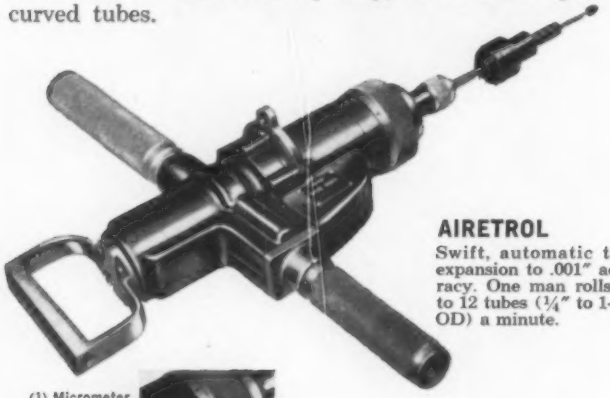
here's why AIRETOOL cuts tube fabrication and maintenance costs

Over thirty years of experience goes into the design of every tool in Airetool's complete line of pneumatic tube maintenance equipment. Air-driven motors provide power to clean and fabricate tubular equipment fast and accurately; to cut equipment downtime; to furnish precision expansion; to cut and remove tubes quickly; to clean straight and curved tubes.



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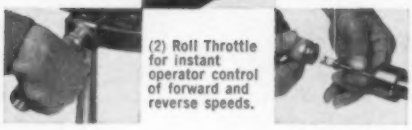
Swift, automatic tube expansion to .001" accuracy. One man rolls up to 12 tubes (¼" to 1-½" OD) a minute.

(1) Micrometer Adjustment for complete accuracy.



(2) Roll Throttle for instant operator control of forward and reverse speeds.

(3) Quick Change Chuck for fast mandrel changing and positive gripping action.

Lightweight, easy, one-man operation for cleaning the hardest deposits from tubes up to 1" diameter. Built-in flushing system washes out scale and cools cleaning head. Complete line of cleaning accessories.

CC-475 CONDENSER CLEANER

And Airetool makes a complete line of straight and curved tube cleaners to meet every tube situation for fast, low cost cleaning and maintenance. For complete information on power equipment, tube maintenance tools call your local Airetool representative or write us for catalog information.

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Engineers' Preview —

continued from page 6

The experiment involves a new engineering development called a non-shaking bag house, discovered accidentally in a cement plant, and never before used on a steel mill's open hearth furnace. The operation uses a series of high temperature cloth filter collectors. Small-scale units which cost from $15,000 to $40,000 each have been tested at each plant. Bethlehem is currently installing a full-scale collector of this type, at a cost of about $250,000, to clean one of its open hearth stacks. Final testing is expected to be completed late this year.

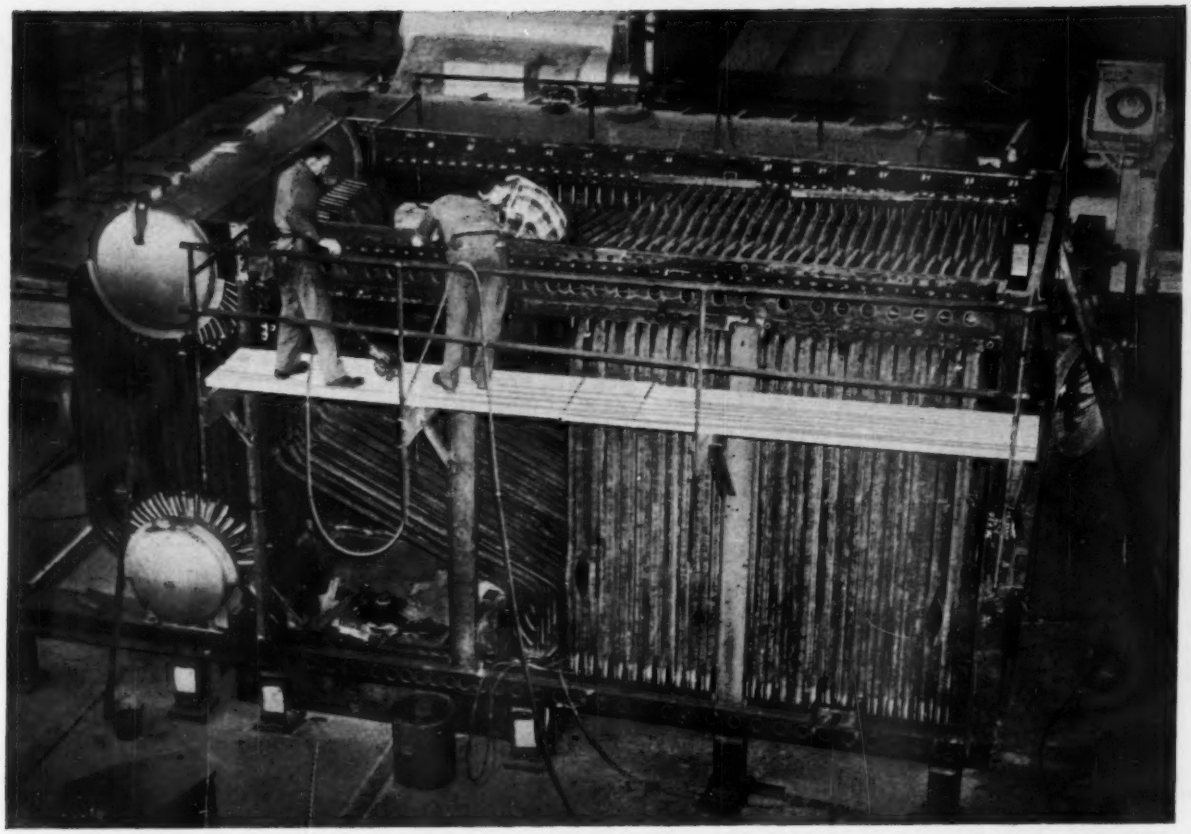
BRISTOL SIDDELEY have developed a mobile 3-Mw turbine generator. This compact, self-contained power pack is reported to cost less than any other generating set of similar capacity. It is designed to be fully adaptable to a variety of uses. It uses as prime mover the Bristol Siddeley Proteus gas turbine, which has a background of 1¾ million hours as power plant of the Britannia airliner.

PACIFIC POWER & LIGHT and Portland General Electric companies, both Portland, Ore., plan to construct 200 miles of 230,000-volt double circuit transmission lines for delivery of the power purchased from two major Columbia River hydroelectric projects in Washington state into the company systems in Washington and Oregon. Cost of the program is estimated at $25 million.

PLANS to build a large steam electric power station in West Virginia have been announced by A. H. McDowell, Jr, president of Virginia Electric and Power Co. As presently planned, this station will ultimately cost at least $150 million and have a total capacity of more than 1 million kilowatts. It is hoped to install the first unit of at least 250,000-kw capacity on the Stony River in Grant County, by 1965.

The Stony River Station will be of conventional design as will the electric switchyard and substation. Vepco also will construct a dam which will impound a 1200-acre reservoir which will be used for cooling.

continued on page 88



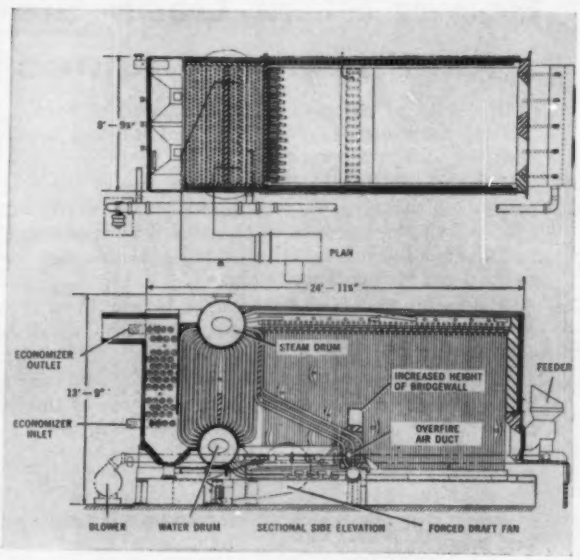
Stoker-fired boiler being shop assembled.

Coal fuels this push-button packaged steam generator

Good news for industry in areas where coal is economical —FW stoker-fired *packaged* steam generators that are comparable with the most advanced gas and oil fired units. Engineered and built with precision, the design has been thoroughly proved and tested in more than two years of operation at full design capacity and above. Performance has been consistently better than expected under all operating conditions.

Units designed for semi-automatic operation are available in three standard sizes: 43,000, 50,000 and 63,000 lb/hr steam capacity at pressures to 250 psig. Push-button control brings these units on or off banked fire. They may be converted to oil firing in a matter of hours. And for easy handling and speedy low-cost erection, they are shipped in three major subassemblies, one of which is the complete boiler and economizer section shown above and at right.

For complete performance and descriptive data on FW stoker-fired packaged steam generators, request bulletin PG59-4. Standard oil and gas fired units are also available in capacities from 13,000 to 100,000 lb/hr. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.



Heat Engineered products, plants and processes . . . for the world's industrial progress.

FOSTER WHEELER

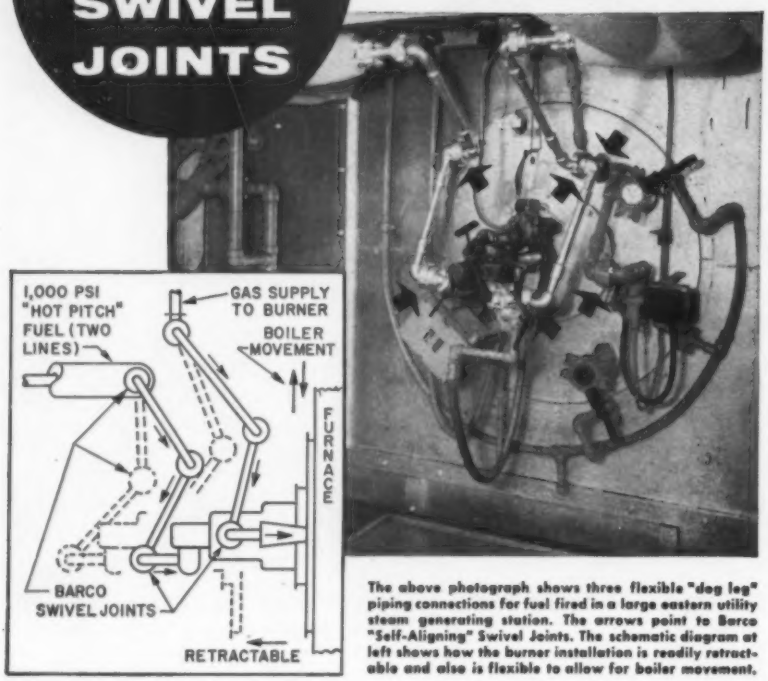
NEW YORK TORONTO LONDON PARIS MILAN TOKYO

For more data circle 536 on Post Card

-Installs
BARCO
Self-Aligning
SWIVEL
JOINTS

SAFETY for Burners

handling 450° Fuel at 1,000 psi



The above photograph shows three flexible "dog leg" piping connections for fuel fired in a large eastern utility steam generating station. The arrows point to Barco "Self-Aligning" Swivel Joints. The schematic diagram at left shows how the burner installation is readily retractable and also is flexible to allow for boiler movement.

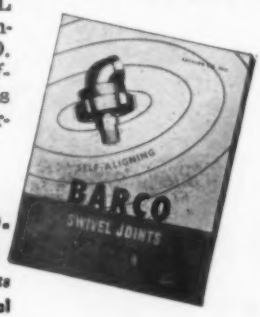
Power Plant Uses Steel Pipe for "Flexible Connections"

THE idea of using steel pipe, instead of hose, appeals to many engineers—especially where fuel is being handled at high temperature and pressure.

In the boiler plant shown above, heavy pitch, obtained from a nearby oil refinery, is pre-heated to 450°—500°F and pumped at 1,000 psi to the burners of the steam generators. On each burner, two 1" lines feed hot pitch; a third 1½" line (painted gray) handles natural gas for auxiliary firing.

Each line is fitted with three Barco Type S All-Steel Swivel Joints with welded connections. Periodically, all lines are purged with 150 psi steam.

With a total of 642 Barco joints installed, only one joint has required any maintenance in two years of service. One of the big advantages of these joints is that they have NO BALL BEARINGS. They don't bake dry at high temperatures. NO LUBRICATION REQUIRED. Another big advantage is that they are *self-aligning;* this eliminates binding and simplifies and speeds up pipe fitting. For detailed information, ASK FOR CATALOG 265D.



BARCO MANUFACTURING CO.
547F Hough Street, Barrington, Illinois
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal

For more data circle 537 on Post Card

GENERAL ELECTRIC has announced a new distillation process for desalting sea water. One of its key features is an assembly of revolving blades which operate much as do an automobile's windshield wipers. Also unusual is vaporization of the water without either boiling or bubbling.

The fresh water produced is said to be salt-free to within one part of salt per million parts of water. The system reportedly can extract 42 pounds of fresh water from each 100 pounds of sea water used, and is applicable to salt, brackish, or polluted water.

The evaporator in the system consists of two vertical tubes, one inside the other. Sea water is fed into the wiper assembly where the slowly revolving blades spread the salt water on the inner surface of the inside tube in a film scarcely one-thousandth of an inch thick.

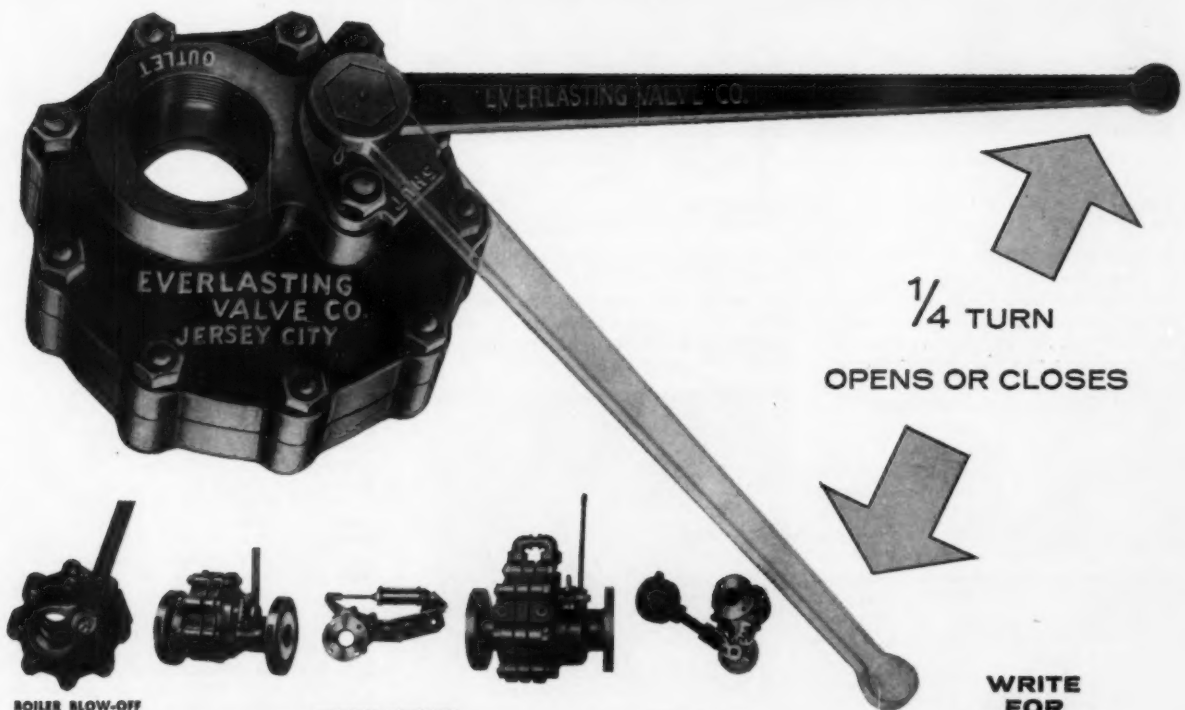
Heat, produced by steam, is transferred through the walls of the inside tube, causing the salt water to evaporate. Pure water leaves the evaporating chamber as vapor, and the concentrated brine is drained off.

ONE HUNDRED TWENTY-NINE electric utility companies are participating either singly or in groups in 25 separate nuclear power projects aimed at attaining economically competitive nuclear power. William J. Clapp, chairman of the Edison Electric Institute Committee on Atomic Power, reports that the electric utility companies' nuclear power development efforts involve utility expenditures of about $700 million.

REA has released $10,558,000 in loan funds to the Arkansas Electric Cooperative Corp of Fayetteville for construction of generation and transmission facilities to meet electric power requirements of seven REA-financed distribution cooperatives in Arkansas. About $9,500,000 of the funds will finance construction of a steam generating plant near Ozarks, Ark. The plant will have a capacity of 44,000 to 50,000 kilowatts. Balance of the funds will be used to build 45 miles of 69-kv transmission line and five miles of 161-kv transmission line.

When you need fast, easy opening and closing with a leak-proof seal and straight-through flow with minimum pressure drop specify

EVERLASTING



BOILER BLOW-OFF Quick acting, also handwheel operated "Y" and angle types. For pressures up to 600 psi.

GENERAL SERVICE Where drop-tight seal and full flow is essential.

CYLINDER OPERATED Can be remotely controlled, electrically or manually.

STEAM JACKETED Assures free flow of viscous materials.

WEIGHT-OPERATED For automatic drains or emergency shut off.

WRITE FOR BULLETIN

EV-409

EVERLASTING VALVE COMPANY, 47 FISK STREET, JERSEY CITY 5, N. J.

For more data circle 538 on Post Card

at Marine Life—world's largest marinearium

HAGAN COAGULANT AID KEEPS WATER CLEAR

Trainer Robert B. Andre feeding dolphins underwater in the main tank.

Quick case history—reading time 59 seconds

Marine Life at Gulfport, Mississippi, incorporates the world's largest marinearium, a tank 82' in diameter, 17' deep, holding 750,000 gallons of sea water. There are, in addition, two smaller tanks, one of which houses the performing dolphins.

Water for the tanks is pumped from the Gulf, and is very turbid and carries a heavy load of algae bloom, particularly in the summer months. This constituted a serious problem for Marine Life, since spectators could not see the fish through cloudy water.

The use of Hagan Coagulant Aid No. 18 was suggested, and since its use was initiated, the cloudy water problem is gone. The water in the tanks is clear and sparkling, and according to Ken Gathe, Director of Exhibits, the far edge of the 82 foot tank can easily be seen through the observation ports.

Hagan Coagulant Aids are non-toxic, easy to handle, and produce a large, tough floc that speed settling time and reduce carryover. They may be either dry-fed or slurry-fed. Write for Bulletin HSP 919 for information on the complete line of Hagan Coagulant Aids.

Overall view of the Marine Life marinearium.

HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN CENTER, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON CO. • HALL LABORATORIES • BRUNER CORP.

For more data circle 539 on Post Card

CONSTRUCTION NEWS

Phoenix, Ariz. — Arizona Public Service Co, 501 S. Third St, has authorized plans for a capital spending program of about $63,000,000 this year as part of a program aimed at doubling its plant capacity in five years. Total plant investment at the end of 1960 was $263,452,000, up 16 per cent from the previous year. Planned program to boost plant investment to $593,637,000 by 1965 is aimed at a system capability of 1,429,000 kilowatts, compared with the present capacity of 827,000 kilowatts.

Crossett, Ark. — Crossett Co, operators of chemical, lumber and paper mill plants at this location, has announced plans for a major expansion and improvement program in connection with these operations here. Included in the plans is the installation of a 20,000-kw steam turbine generator for increased capacity. Installation will include a bark and gas-fired boiler and various pipe lines necessary to this project. Work will begin soon for completion scheduled for the summer of 1962. Cost of the project when completed is reported to be about $4,000,000.

Lawrenceburg, Ind. — Indiana and Michigan Electric Co, 2101 Spy Run Ave, Fort Wayne, Ind., has plans under way for a major expansion of its Tanners Creek Plant located here. Included in the plans is the installation of a new steam electric generating unit with an initial capacity of 580,000 kw, which will be the fourth unit installation at this station. Work will begin early this summer and is scheduled for completion by the spring of 1964. Cost of the installation when completed is reported to be over $73,000,000.

Harrodsburg, Ky. — Kentucky Utilities Co, 159 W. Main St, Lexington, Ky., has authorized plans to construct a new generating unit at its Dix Dam station located near here. The new generating unit's capacity of 156,250 kw will be the largest in the company's system. Work will begin when preliminary engineering work is concluded and is scheduled for completion by June 1963. Cost of the entire installation is reported to be about $17,500,000.

Minneapolis, Minn. — Northern States Power Co, Minneapolis, Otter Tail Power Co, Fergus Falls, Minn., and three rural electric cooperatives have plans under consideration for the forming of a power pool in North Dakota, and propose to construct five power plants costing over $125,000,000 by 1977. Options on a site along the Missouri River in west central North Dakota have been obtained and at least two of the plants will be built there with provisions for the other three. Each of the plants would have a capacity of 200,000 kw and would be built by one of the members of the pool on a staggered basis, with the first to be completed about 1966 and the last about 11 years later, providing twice the power output available from existing plants.

New York, N.Y. — Avco Manufacturing Corp, 420 Lexington Ave, has announced that 12 electric utilities, in cooperation with the company, will spend approximately $1,200,000 this year to develop further a method of generating electricity through a heated gas. Company has made

substantial progress in the past year with a magnetohydrodynamic (MHD) generator. In this device, gas heated to about 5000 F shoots through a magnetic field and produces an electric current. Chief advantage of MHD lies in the elimination of the mechanical steam or motor-driven turbine which spins the armature.

New York, N.Y. — Consolidated Edison Company of New York, 4 Irving Place, has announced that the Public Service Commission of the State of New York has authorized the company to absorb Consolidated Telegraph and Electrical Subway Company, a wholly owned subsidiary. The assets of the subsidiary are estimated at more than $170,000,000. The giant utility now rents from it, underground conduits for its electric operations in Manhattan and the Bronx. Once the merger is effected, Consolidated Edison will be relieved of jurisdiction of the Public Utility Holding Company Act that subjects it to jurisdiction of the Securities and Exchange Commission.

Portland, Ore. — Pacific Power & Light Co, Public Service Bldg, this city, has announced that the proposed merger of California Oregon Power Company into Pacific Power & Light Company has been approved by the stockholders of both companies at special meetings held recently. Under terms of the merger, 1.2 shares of Pacific common will be exchanged for each share of California Oregon Power common, increasing Pacific Power's outstanding common shares to 6,624,394 from 4,411,715. The merger will take until midyear to complete and is subject to approval by the Federal Power Commission and state regulatory authorities.

Sioux Falls, S.D. — A merger of Southern Colorado Power Co, Pueblo, Colo., into Central Electric & Gas Co, 116 S. Main Ave, this city, subject to approval of Colorado regulatory authorities, was approved by stockholders of both companies at special meetings. Upon completion of the merger early this summer, the combined company will be known as Western Power & Gas Co, with headquarters here. Central Electric & Gas Co operates natural gas distribution facilities in Nebraska and South Dakota and provides telephone service in seven states. Southern Colorado Power Co provides electric service in the southeastern part of Colorado.

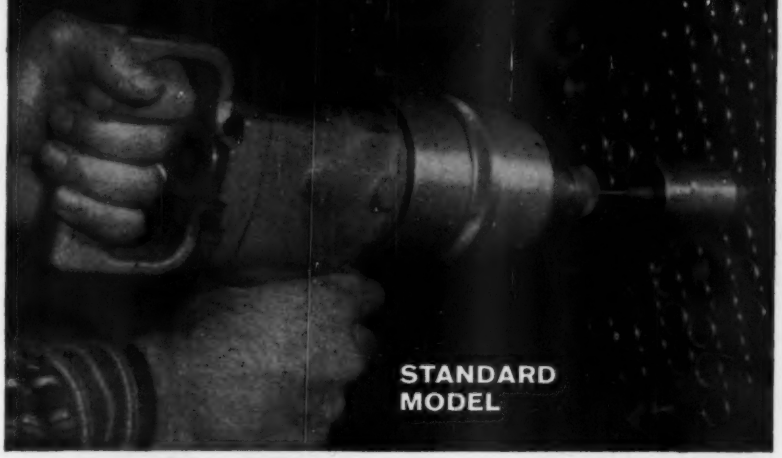
Knoxville, Tenn. — Tennessee Valley Authority, New Sprankles Bldg, has announced the award of a contract to Combustion Engineering, Inc, New York, N.Y., for the boiler of one of two large steam turbine-generators it has on order with General Electric Co. Contract includes an option for a second boiler at a price of $17,440,000 for one and $34,660,000 for two. At the same time TVA has accepted an alternative design for two turbine-generators which will increase the guaranteed gross generating capability of the units by 35,000 kw to 900,000 kw each. The change will add $1,000,000 to the cost of each unit, bringing the total cost for the two to more than $32,764,000. The first of the two units is scheduled for completion by September 1964.

Dallas, Texas — Houston Lighting & Power Co, Houston, and three operating subsidiaries of Texas Utilities Co, Dallas, announced plans for a jointly financed high-voltage electric transmission line between the Dallas-Fort Worth area and Houston, Texas. The project, reported to cost over $25,000,000, will connect with

continued on page 101

ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling



Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Tube Expanders and Related Accessories

Elliott offers a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 types, ranging from ¼ in. to 3½ in. O.D. Also the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor.

Elliott Tube Gage

WRITE for Bulletin Y-53

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio; Newark, N. J.

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS
DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

For more data circle 540 on Post Card

Equipment News

Described on these pages are new and improved products. Use Reader Service Cards on pages 103–104 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—Control computer can function as instrument alarm scanner

The RW-300 Digital Control Computer is now available with a subsystem that immediately warns of unstable operating conditions within the plant being controlled, according to TRW Computers Co., Div., Thompson Ramo Wooldridge Inc. Unusual operating trends are detected automatically by this instrument-scanning subsystem, without interrupting computer's control calculations.

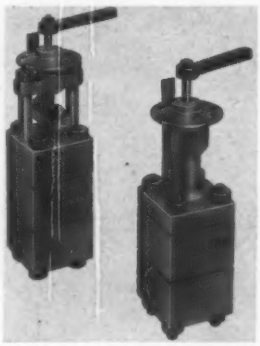
With this capability, the RW-300 exercises continuous control of a process while simultaneously scanning plant instruments to detect abnormal operating trends. These are detected whenever instrument readings deviate beyond prescribed limits — checked automatically by the built-in analog-to-digital subsystem. When an out-of-limit is detected, the computer notifies the operator and initiates necessary control action. The system tests more than 1000 readings against both upper and lower limits within 2 to 8 sec — an average of 200 per second. Critical instruments can be scanned at higher rates.

2—Slurry pumps approximate efficiency of clear water pumps

Laboratory tests of the JC Pumps are reported to demonstrate excellent hydraulic and abrasive characteristics which let the pumps operate on less horsepower and prolong the life of their wearing parts. Announced as a "smaller family of pumps" than the RX line of heavy-duty slurry pumps produced by Morris Machine Works, this company's new JC line has been developed to offer low first costs, easy maintenance and constant operating reliability. It features standardized components, availability in medium, hard or extremely hard metal casings, impellers and liners; stainless steel shaft sleeve.

4—Block steel valves for heavy-duty flow regulation

Introduced by McAlear Mfg. Co. for rugged applications, Models 37 (right of photo) and 38 Valves are suggested for use in continuous boiler (surface) blowdown systems, hydraulic service, instruments, throttling service, water column blowdown, soot blowers, boiler sampling service and flow control of volatile liquids. Featuring a heavy design and extra thickness at wear points, the



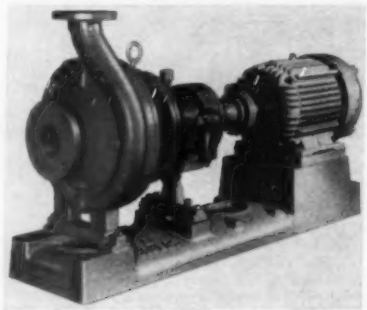
valves come in carbon steel or chromemoly steel. They are said to provide accurate flow regulation within 1 per cent of desired flow, and to resist excessive cutting arising from continuous throttling of a liquid. Pressure-temperature limitations are 1500 psi at 800 F. Bolted body design permits use of non-threaded seat and simplifies inspection. Model 37 has inside stem threads; Model 38, outside stem threads. Both types are available in connecting pipe sizes from ⅜ to 2 in. Specifications and price information are provided in Bulletin 169.

5—Large size readout lamps display letters and numbers

Style RA 4000 Rayescent Readout Lamps, Westinghouse Electric Corp., have outside dimensions of $3\frac{5}{16}$ by $4\frac{3}{4}$ in. When mounted with other lamps, each uses only $3\frac{3}{8}$ in. of panel width. They produce a high visibility green light, can be read at distances to 150 ft, depending on ambient conditions. Letters are formed by energizing specific segments, and since all segments are on the same plane, the letters and numbers formed are readable even at wide angle viewing. The lamps operate at 240 or 460 v, 60 or 400 cycles per second, with electrical contact made by pins molded into the back. Rated useful life is 5000 hr; however brightness decreases as the lamps are operated. Average brightness is increased as voltage is raised. Compact, transistor type power packs can be had for converting 60 cps or low voltage d-c power into 400 cycles when higher brightness is necessary. Individual lamps cost around $25.

6—Centrifugal pumps built for maximum interchangeability

Model 3195 Centrifugal Pumps are introduced by Goulds Pumps, Inc. as featuring maximum interchangeability of pumping units and parts, simplified installation and maintenance, and mechanical reliability. Horizontal, end suction, single stage units, they are designed for chemical processing, petrochemical and petroleum refining appli-



cations, but adaptable for any industry using chemicals . . . corrosive or abrasive, cold or hot (−350 to 500 F), clear liquids or slurries.

Eleven sizes provide capacities to 775 gpm, heads to 300 ft, and all are top centerline, back-pull-out design. All sizes are 23 in. long, have the same 4-in. dimension end of suction to centerline of discharge. A $1\frac{1}{8}$ in. coupling fits all sizes, and there's only one spacer coupling length ($3\frac{1}{2}$ in.). One bolt size ($\frac{1}{2}$ in.) holds pumps to bases. The line is stocked in three standard constructions: ductile iron, stainless steel 216, and Gould-A-Loy 20. Other metals can be

3—Phasing test set identifies underground cable systems

This set, and method employed, are for phase or conductor identification on underground cable systems. A development of James G. Biddle Co., it is claimed to reduce costs without lowering safety practices, permitting use without removing all safety grounds. The transmitter consists of a packaged steep-wave-front impulse circuit connected to the cable terminal which periodically sends a pulse out on one identified conductor (for example, A phase) and back on another (for example, B phase). The transmitter can be operated from a 60-cycle supply or from self-contained dry cells.

The detector (for identifying individual conductors) is similar to a clamp-on ammeter. When clamped around the A phase conductor, it gives a pointer deflection in one direction: in the opposite direction for B phase and no deflection for C phase. In actual manhole tests, all three conductors are connected to ground after exposure, and the detector clamped around each ground connection consecutively. Safety grounds ahead of or beyond work location can be left in place. Safety grounds at terminal where transmitter is connected can, in some cases, be left on also. The transmitter can also be used to identify cable itself at work location. Further information is provided in Bulletin 82-24.

ordered. Top centerline discharge is self venting and simplifies piping, and the back-pull-out design enables easy replacement of parts most subject to wear without disturbing pipe connections or motor mounting. Bulletin 725.8 gives full information.

7—Sheet packing made of compressed asbestos and synthetic rubber

Tests qualify the improved Style 340 as a multi-purpose packing material of the type formerly available only in premium grade packings, according to manufacturer, Keasbey & Mattison Co., yet it's offered as a standard item. The material is reported successful against steam, water, petroleum oils, refinery gases and hydrocarbons.

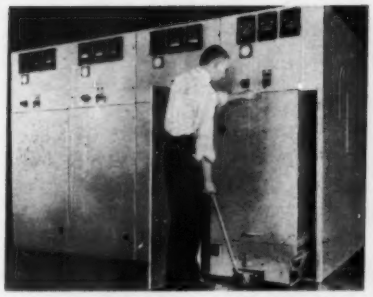
8—Industrial control system is suited to variety of uses

As announced by International Business Machines Corp., the 1710 is designed for a variety of uses calling for frequent sampling and interpretation of data, as in quality control, industrial process study and process optimization. As a control system, the 1710 scans up to 300 instruments at regularly-timed intervals

and gives instructions for adjustment of control settings. The 1710 is composed of company's 1711 data converter, which translates instrument readings into language understood by a computer, and the solid-state 1620 data processing system. The 1620 digital computer, an integral part of the 1710, may be used independently of the control system to perform processing jobs. An already installed 1620 system may be converted in the field into a 1710 system. Purchase prices of the 1710 range from about $111,000 to $135,000, depending on optional features. Monthly rentals start around $2600.

9—High speed grounding switch for power system lines

Type PGH Switches of Line Material Industries are actuated by a relay which senses a low-magnitude fault, such as an internal fault in a transformer. The six-cycle closing of this switch quickly establishes a high-magnitude fault which can be sensed by the relay of a backup circuit breaker. Thus the effective range of a breaker can be extended economically. Voltage ratings are 23–34.5 and 46–49 kv. Both units are rated at 20,000 amp momentary closing current. Six-cycle closing time includes trip coil operation. Consisting of oil-filled porcelain housing, internal contacts and enclosed mechanism, the Type PGH can be mounted on a substation structure or separate pedestal.



10—New 13.8 kv equipment features stored energy closing

This 13.8 kv equipment of I-T-E Circuit Breaker Co. incorporates new design from the ground up, specifically for stored-energy closing. In the new breakers, the stored-energy closure employs a motor-charged, spring-powered mechanism which provides faster contact closing, improved contact life and greater safety. The breakers also feature face-wound blowout coils which provide faster fault interruptions through improved arc extinction afforded. Weight of arc chutes also is reduced for easier handling and maintenance. Compact size and low center of gravity permit smaller overall size of switchgear, easier and safer handling. One man can handle the 250 mva breaker. Breakers in the other three interrupting ratings available — 500, 750 and 1000 mva — require only two men for handling during maintenance.

Switchgear construction incorporates closed-door drawout, permitting movement from operating to test and disconnect positions with compartment door closed. Other features are reduced size (depth reduced up to 18 in.); closed door indication; and improved bus and wiring design. Types of construction available include the conventional indoor arrangement, and two outdoor configurations: standard enclosed and full walk-in.

11—Proportioning pump can be adjusted while running

Capacity of the 300 Series Proportioning Pump can be adjusted while the pump is running, according to American Meter Co. It features a control mechanism in which outputs of two cams are combined to vary stroke of zero to maximum. The simplex model has capacity from 1 to 812 gph; the duplex model, from 2 to 1624 gph. Maximum working pressure is 10,000 psi. Interchangeable liquid ends from a variety of corrosion-resistant materials allow for variety of pumping applications.

12—Distribution arrester reduces impulse sparkover

Improvements announced by Westinghouse Electric Corp. for this low-voltage arrester (3 to 27 kv) include reduced impulse sparkover and discharge voltage characteristics, as well as reduced weight and size, easier handling and mounting, using less room on pole. Non-explosive dropout is designed to prevent line lockout in event of a damaged arrester. Power follow current not "valved off" in ½ cycle after discharge of a lightning stroke actuates a thermal element in dropout device to separate ground stud from the arrester body.

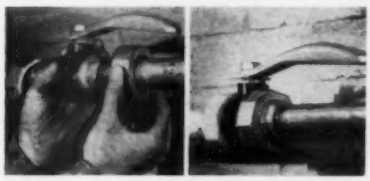
13—Center-mounted derrick operable from rotating crow's nest

The 7700 Hydraulic Derrick can be mounted on the chassis at any point behind the cab and requires only 18 to 26 in. of mounting space. Produced by Holan Corp, this derrick — including base, superstructure and hydraulic outriggers — is an integral unit to minimize body and derrick stresses. Seated in the crow's nest, the operator has an unobstructed view of his work area and can dig, "live boom" up to 9000 lb, rotate 360 deg in either direction and extend and retrace the 7-ft boom. Foot pedal controls rotate the derrick and operate the digger; derrick vertical movement and boom extension and retraction operations are controlled by hand levers.

The unit has a head sheave height of 32 ft. maximum, operating through a range of 108 deg. It has an offset sheave design which holds the pole away for the derrick leg, providing additional clearance for pole handling. Optional equipment is a semi-automatic locking device. It locks the earth borer to the extendible boom for digging, and automatically locks borer to end of main boom when retracted.

14—Ball valve is versatile and easily installed, too

This ball valve, by Clayton Mark & Co., features improved sealing, one-piece body, and built-in union ends which simplify installation, operation and maintenance. In a two-step installation procedure, union ends are screwed or welded to pipe ends, and the valve body then assembled to the union nut. Minor pipe misalignment can be over-



come without affecting valve seal which is in the valve body.

For maintenance, the downstream line can be disconnected with valve under pressure without adding extra parts. In difficult locations, valve body can be rotated under pressure. Also, the stop plate can be adjusted to position the handle in any of four quadrants — the handle can even be attached upside down. Principal advantage of the dual seat design is that the ball, which floats between the seats, makes a tighter seal as it is forced against the downstream seat by increasing pressure. Pressure at the upstream seat is then equalized by

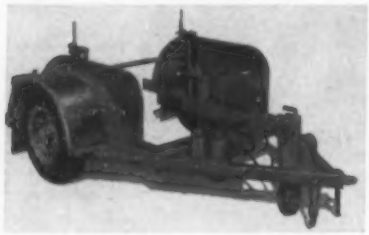
permitting the fluid to get behind the upstream seat. Thus low frictional resistance is maintained and the valve can be turned easily. Valve comes in stainless steel, carbon steel or brass in eight sizes from ¼ through 2 in. Seats can be Buna-N, Neoprene or Teflon.

15—Oil valve promotes combustion efficiency, saves on fuel

Besides stepping up combustion efficiency, the 4-P Oil Valve reduces fuel consumption and maintenance costs for oil burner type heating systems, according to Dawson Enterprises. It also serves to eliminate excessive smoke and soot, poor modulation, and excessive preheating of oil. This self-cleaning valve is engineered for Nos. 4, 5 and 6 oils, for manual, semi-automatic or fully automatic systems. It can be installed on present burner without removing burner's components and can be driven by existing modulating motor.

16—Hydraulic cable reel trailer can be operated by one man

Economy priced, the Series RM Reel-Master is announced by McCabe-Powers Body Co. as offering performance features of more expensive cable reel trailers. One man can load and attach it to the towing vehicle without help of crane or winch. Two hand-



operated pumps with independent hydraulic cylinders enable him to elevate and level the reel to payout or travel position, and a diverter valve permits operation of the landing wheel cylinder with the same pumps. When this trailer is being parked on uneven ground, the cylinders raise or lower either side of the reel to facilitate removal or cable payout. Three sizes provide for carrying reels up to 54 in. wide, 96 in. in diameter and weighing up to 8000, 10,000 and 12,000 lb.

17—Air compressors feature individual cylinders

Maximum cooling and lowest operating temperatures are claimed by Davey Compressor Co. for these reciprocating air compressors with individual cylinders of nickel-iron alloy with deep radial fins. Single and two-stage units, ranging from 7½ to 150 hp, are available, in direct connected and V-belt driven types. Single stage compressors are suitable for operation at 50 psi continuous pressure; two-stage at 125 psi. Unloaders are of suction valve type which hold intake valves off seats when pressure reaches maximum setting. When pressure drops 10 psi, valves are released to operate from an adjustable pilot control valve. Automatic start-stop or dual controls are also available. Bulletin S-100 gives further details.

18—Motor starter has built-in protection for men, equipment

This combination magnetic starter with double-door dead-front construction is designed by General Electric Co. to

discourage unauthorized entry. For normal maintenance, the main door can be opened with a screwdriver, with circuit breaker (or disconnect switch) in "off" position. An additional screw must be turned for entrance to enclosure with breaker in "on" position. In "off" position, and with main door open, breaker can be turned "on" only if a defeater mechanism is depressed — protecting maintenance personnel against power being accidentally turned on while they're working.

The dead-front panel covering the breaker may be opened with breaker in "off" position by loosing a captive screw. With breaker in "on" position, you must operate another defeater mechanism in the switch handle before the dead-front panel will open. Authorized personnel may padlock the operating handle on the starter in "off" position and the entire enclosure may be padlocked — but the handle cannot be padlocked in "on" position. The starter consists of a magnetic motor starter, control transformer and branch circuit protective device (circuit breaker or disconnect switch). It comes in a NEMA Type 12 enclosure, Sizes 1 and 2.

19—Shell and tube exchangers use standardized parts

Lower equipment costs and faster delivery are advantages announced by The Griscom-Russell Co. for Pre-Engineered Heat Exchangers. They are said to meet all but the most unusual requirements, and acceptable modifications from standard construction provide flexibility in meeting unusual specifications of large users. Using standardized components, the exchangers are available in tube lengths of 16, 20 and 24 ft. Shell diameters range from 21 to 45 in. ID by approximately 1-in. increments. Two, four or six passes of the tubeside fluid are available. Standard design pressures are 150, 300 or 450 psi tubeside and shellside. Bulletin 101 gives full data.

20—Butterfly valves are compact in design, light in weight

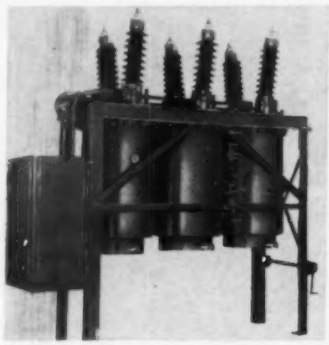
Introduced by Lunkenheimer Co., these butterfly valves are rated at 150 lb water pressure, cover a pipe size range from 2 to 18 in. They have nickel-plated cast iron or cast steel bodies, stainless steel trim; modifications for special applications are available or some models. According to manufacturer, these butterfly valves are particularly suited to new installations because their compact design and light weight eliminate need for additional line bracing. As a replacement, the flange end butterfly valve fits horizontal space occupied by comparably rated gate valves.

The new butterfly valves, utilize O-ring seals to provide closure on vacuum or pressure service. In lever operation, they open or close on a quarter turn. Gear operation is optional in larger sizes. All sizes are available with valve as a separate element with interchangeable bolt-on flanges for screw, weld, flange or groove installations. In diameters up to 6 in., valve may be had as an integral unit.

Reader Service Cards on pages 103–104 make it easy to get further product information.

21—New 69-kv power breaker has faster arcing interrupter

Incorporating new Kool-Arc interrupters, the Type KM Subtransmission Breaker is said to feature design innovations not previously available in the 69 kv ratings. The interrupter provides shorter arcing time and reduces the degree of contact and erosion and oil deterioration, according to manufacturer, Power Circuit Breaker Div. of I-T-E. The Kool-Arc tube is high-strength, non-absorbent Fiberglas and epoxy construction, and the overall smaller size of the vertical interrupter



provides greater internal clearances and permits a reduction in tank diameters. These breakers also have a simplified breaker linkage system, improved operating mechanism and a new clean look resulting from use of smooth pressed steel heads, simplified conduit system for the transformer leads, and lower pull-rod housings.

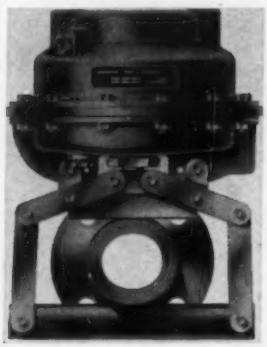
22—Reduced voltage starter incorporates safety features

This Size 6 autotransformer-type, reduced voltage starter is reported to meet both JIC standards and NEMA requirements and to incorporate new safety requirements of the automotive industry. Produced by Westinghouse Electric Corp., it features an operating handle permanently attached to the circuit breaker to provide indication and

control of the breaker with the door either open or shut. Handle and door are interlocked to prevent opening of door with breaker in the "on" position and to prevent closing of the breaker with the door open. The starter also uses Type GP 600-amp a-c contactor featuring small size and front panel mounting and wiring.

23—Automatic valve works in hazardous, inaccessible spots

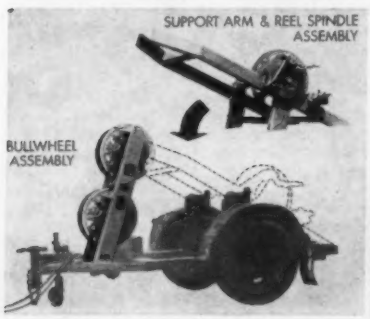
This Flex Valve is designed by Farris Flexible Valve Corp. to control highly abrasive slurries and corrosive materials in locations considered too hazardous or inaccessible for manually operated valves. According to company, anything that flows through a pipe will flow



through this valve, and it closes bubble tight even on small solids. Its flexible pipe-like body provides full capacity and unobstructed flow, absorbs vibration and is unaffected by water hammer. A diaphragm motor permits automatic control. Valve comes in a range of body materials, in sizes 1 to 12 in., slip-on and flanged connections. To install, you simply slide the rubber body over connecting piping and tighten clamps. Catalog FL-1116R gives details.

24—Bullwheel assemblies mount on existing reel dollies

Pengo Bullwheel Assemblies, Models 5000-U and 6000-U, announced by Petersen Engineering Co., Inc., are identical to those used on 5000-STR-1 and 6000 Series Pengo tensioners. Each consists of a pair of multi-groove Neoprene-lined aluminum alloy bullwheels with tensioning brakes, and a direct knob type brake control is provided on each bullwheel without intermediate linkage, assuring smooth payout of the conductor. The 5000-U accommodates up to 636 MCM ACSR or 795 MCM aluminum conductor; the 6000-U handles conductors to 1.39-in. diam. Smaller



ROTO® Hand-hole Seat Scraper

Eliminates tedious labor

Assures clean, tight fit

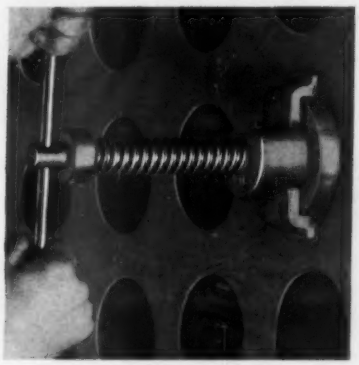
Roto Hand-hole Seat Scraper for B & W Boiler.

Roto Hand-hole Seat Scraper makes short work of cleaning dirty hand-hole seats. This simple, hand-operated tool has adjustable, spring-mounted retractable knives. A few turns to the right remove foreign matter without cutting the metal. A half turn to the left releases the tool, and the job is done. Customers say that the Roto Seat Scraper does the job up to 12 times faster than by any other method. Try one and you'll wonder how you ever got along without it. ***Send for details.***

Now available

for most hand-hole shapes and sizes

Standard Roto Seat Scrapers are available for the following equipment. Special types made to order.



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Type of Boiler	Opening	Tube Size
Babcock & Wilcox # 4	Round	2"
" " " #41	Oval	2"
" " " #70	Round	3"
" " " #48	Oval	3½"
" " " #40	Oval	3¼"
" " " #24	Oval	4"
" " "	Oblong	4"
Bros	Round	3¼"
Casey Hedges	Oval	3½"
" "	Oval	4"
Combustion Eng'rg	Round	3"
" "	Oval	3"
Edgemoor	Oval	4"
Erie City	Ellip	2½"
" "	Oblong	3¼"
" "	Ellip	3¼"
" "	Pear	4"
Foster Wheeler	Oblong	2½"
" "	Oblong	3"
" "	Ellip	4"
Geary	Oblong	4"

Type of Boiler	Opening	Tube Size
Heine	Round	3½"
"	Oval	3½"
International Boiler 2	Oblong	3"
Keeler	Round	3½"
"	Round	4"
"	Diamond	3½"
"	Diamond	4"
Lasker	Oblong	
Murray	Oval	3½"
"	Oblong	4"
Oil City	Oval	3½"
" "	Oblong	4"
Riley Stoker	Ellip	3¼"
Springfield	Ellip	3¼"
Union Iron Works	Pear	4"
Henry Vogt	Ellip	3¼"
" "	Oval	4"
Walsh & Weidner	Oval	4"
Wickes	Ellip	2½"
"	Ellip	3¼"
"	Pear	4"
"	Round	4"

ELLIOTT COMPANY – ROTO PLANT

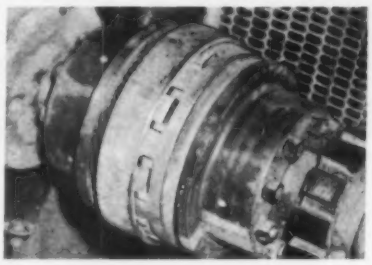
Tube Cleaner Specialists Since 1910

1071-47 Bristol Road, Mountainside, N. J.

sized conductors may also be strung. A fairlead assembly is included so the unit may be mounted at the usual angle of 75 deg when reel is carried on the same trailer, or 22 deg when carried on a separate trailer.

25—Heavy-duty flexible couplings for applications to 8500 hp

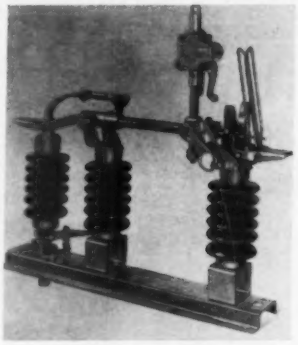
For severe and continuous service, the Type H Couplings of Lovejoy Flexible Coupling Co. incorporate individual load cushions which transfer the entire load, eliminating metal-to-metal contact at the jaws. Shaft connections are made with a simple alignment procedure, using only a straight edge. The couplings are said to require little maintenance and no lubrication. On non-reversing loads, advancing or reversing load cushions serve to provide double cushion life. Cushions can also be removed without



disturbing driving or driven units. The couplings are available with bore sizes to 9½ in. Bodies and jaws are machined electric steel or nodular iron castings. Catalog 61, Section A, gives full data.

26—Distribution load break switch has power class features

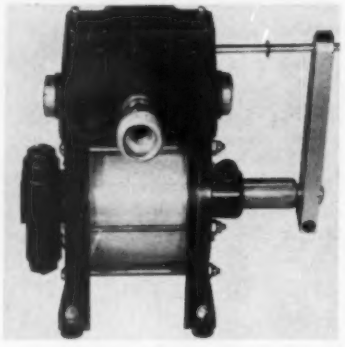
The AIR-60 is designed by James R. Kearney Corp. to provide for distribution switching equipment, the operating and load breaking capabilities presently available only in power class switches, but at a price level customary for that service. It is built for use at 600 amp in ratings of 7.5, 15 and 23 kv. New features include rotating, blade, high



pressure contacts, and an enclosed hinge for protection against corrosion and ice. The ARI-60 is literally a small power class switch, incorporating three insulator stacks with a vertical blade motion controlled by rotation of the rear stack. The blade first rotates on its own axis to relive contact and then is elevated to open position. Excellent mechanical advantage is said to be provided by the simple three-link blade mechanism. Bulletin Section 8C gives complete data.

27—Automatic proportioner works on water pressure alone

Water power supplies the "juice" for the Model V-1 Prime Proportioner, a compact, flow responsive unit produced by Proportioning Devices Co. It can be hooked up to any line with two standard



T fittings, cut-off valve and two pieces of hose. Engineered for precise economical measurement of liquid solubles, the proportioner treats up to 300 gph of water, delivering 1 oz of any water-soluble solution per gallon. Proportions are maintained even though water pressure fluctuates. The unit weighs only 3½ lb, is 7½ in. high. It can be carried about or permanently installed as part of a watering system.

. . . in the chemical treatment of your WATER—STEAM—FUEL. For over 70 years Western's special formulas and individual technical service have been controlling scale, corrosion, foaming, algae, sludge, soot, and related operating problems. Ask for the brochures that apply to your own needs.

WESTERN CHEMICAL COMPANY

717 Washington Street Kansas City 5, Missouri

For more data circle 543 on Post Card

Reader Service Cards on pages 103–104 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

28—Distribution transformers with overload capabilities

This lower and lighter oil-immersed line of Endur-All Distribution Transformers, introduced by Allis-Chalmers Mfg. Co., offers greater overload capabilities

through larger cooling duct area, higher-temperature insulation, and higher temperature oil. Lower impedances permit utilities to take full advantage of overload capabilities. Locked core and coil assembly provides high short-circuit strength and does away with nuts, bolts and welds. High-gloss paint used on the transformers provides tough finish with underfilm corrosion resistance and long service properties.

29—Baby hydraulic power pump develops up to 10,000 psi

Model 1729 is a miniature, portable two-speed hydraulic power pump weighing only 14 lb. Available from Greenlee Tool Co., it incorporates higher volume,

low-pressure pumping features which provide fast approach ram action with automatic changeover to low-volume, high-pressure drive. Approximate capacity is 80 cu in. at 30 psi, 20 cu in. at 100 psi, and 4 cu in. at 10,000 psi. The

WHEN YOU NEED HELP IN A HURRY—

Koppers coupling service cuts costly down-time

Not every coupling service need is an emergency. But it's the emergencies that really test a good organization. That's why Koppers maintains experienced field engineers and outstanding stock facilities throughout the country. In addition, if it's a Fast's Coupling you're replacing, we have a serial number and specific application history for every Fast's for easy reordering. And our modern manufacturing facilities have the extra capacity to lick an emergency for special requirements.

Example: A modern windowless bank in Georgia was able to open for business as usual only because Koppers flew in a completed replacement coupling for its air conditioning unit. Elapsed time . . . request phoned to Baltimore after 10 in the evening . . . coupling arrived before 7:30 next morning.

KOPPERS COMPANY, INC., 1205 Scott St., Baltimore 3, Md.

KOPPERS

FAST'S COUPLINGS

Engineered Products Sold with Service

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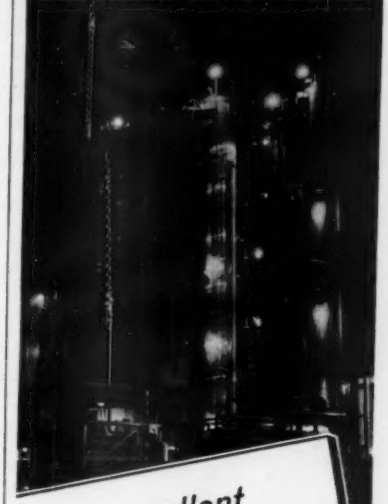
For the Savannah Plant of SOUTHERN NITROGEN CO.



"...excellent trouble-free service" **against SURGE PRESSURES**

Handling hot potassium carbonate requires safeguarding pumps and piping systems against dangerous pressure surges. Eight Williams-Hager Silent Check Valves—similar to the one shown at right—guard Southern Nitrogen's Savannah Plant by operating *instantly* when flow reversal starts or when flow is zero.

Write for Bulletins: #654 on Valves; #851 on Cause, Effect and Control of Water Hammer; #659 on Pressure Loss Tests.

WILLIAMS • HAGER

Silent Check Valves

The Williams Gauge Company, Inc.

143 Stanwix Street • 2 Gateway Center
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Our 75th Year • 1886-1961

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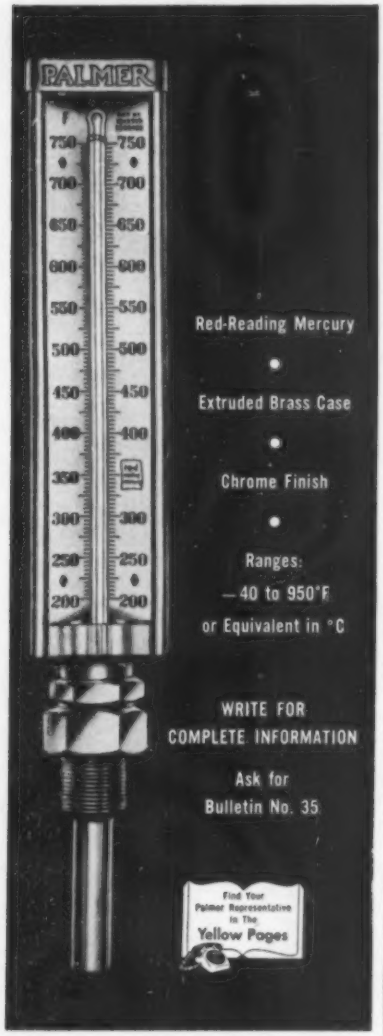
TODAY'S MODERN INDUSTRY
DEMANDS A MODERN THERMOMETER

PALMER

RED-READING MERCURY THERMOMETERS



PALMER

PALMER THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording
and Dial Thermometers • Cincinnati 12, Ohio

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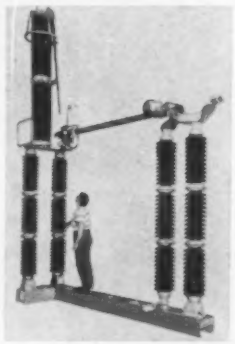
pump develops 10,000 psi intermittent, 6000 psi continuous, and is suggested as a power source for electricians' hydraulic knockout punch drivers, rams, jacks, pullers and systems with similar high pressure, low-volume requirements. It is powered by a built-in 115-v ac-dc universal motor and has built-in two-way control valve. For remote control operation, Model 1729-PO has pendant electrical switch, longer power cord.

30—Vacuum type interrupter has vertical break disconnect

Built by Delta-Star Electric Div., H. K. Porter Co., Inc., the MKV-40 Switch is introduced for use in place of an oil circuit breaker at about a fourth of the cost. It is designed to interrupt a 230-kv transmission line and is a combination of vertical-break disconnect and eight vacuum interrupters stacked in series, one above the other. The glass-enveloped interrupters are enclosed in a 9-ft porcelain tube mounted



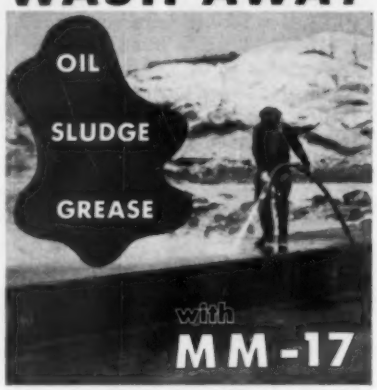
adjacent to the jaw contact. Each individual vacuum switch can be given a voltage test without removing the stack from the porcelain.

The complete unit is 18 ft high — its height and weight require an extra supporting insulator stack at the front end, giving it four such stacks instead of three as on a conventional vertical-break air switch. Operation is automatic. On opening, the disconnect blade rises, picks up an aluminum arm extending into its travel path from a mechanism atop the interrupter tube. As the blade touches the arm, current is shunted through the vacuum interrupters. When the arm reaches a predetermined position, the interrupters are opened. The blade then drops the arm, which is spring-driven back to normal position.

31—Demand ammeter for installation on voltage regulators

Now available from General Electric Co., at no increase in price, is a dual-range 5-amp meter with 8 amp scale.

WASH AWAY



Sea wall at Scituate, Mass., where heavy deposit of bunker oil from sunken tanker was completely removed by spraying MM-17 on oil and hosing off with water.

- **Quickly and safely emulsifies oil spills**
- **Flushes clean with fresh or salt water**
- **Non-explosive, no toxic vapors, does not burn skin**

MM-17 overcomes emergencies caused by oil spills on land or water. It is the safest and most efficient emulsifier extensively used for this purpose.

MM-17 cuts through deep layers of heavy oil and sludge where ordinary solvents fail. Here is a scientific cleaner for oil tanks, pipe lines, piers, loading platforms and oil handling equipment.

MM-17 is sprayed or brushed on the surface to be cleaned. In minutes, oil and grease can be hosed off or wiped away.

Get ready now for annual clean-up and emergencies. Order MM-17 today and have it on hand when you need it.

Single drums (55 gal.) . . . . . $2.42/gal.
Six drums on same order . . . . $2.18/gal.
Bulk shipment prices on request.

FREE Barrel Drain Truck with first order. Listing for $31.50, this truck is yours free with your first drum of MM-17.

ROCKLAND INDUSTRIES, INC.
CHEMICAL DIVISION
63 Grove Street
Rockland, Massachusetts
TRiangle 8-5340

For more data circle 547 on Post Card

It permits high range readings up to 160 per cent of load at full scale and low readings up to 80 per cent of load at full scale. Value of this meter, according to manufacturer, comes from its flexibility in being able to provide accurate readings in the face of loads which may be above or below those for which the regulator is designed. It utilizes the same adapter and socket as company's previous models.

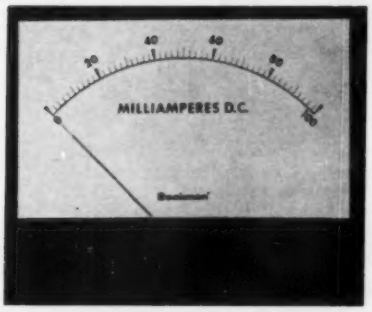
32—Static inverter power supply gives continuous a-c output

For utility and other applications requiring continuous emergency standby power, General Electric Co. offers a highly regulated static inverter which

converts d-c power from a 129-v floating battery source to 115-v, single-phase, 60-cycle a-c. It incorporates a controlled rectifier as principal power regulating device and features convection cooling to provide lower preventive maintenance. This 2.5 kw static unit is said to operate at an efficiency reaching 80 per cent over a range of +10 per cent to −18 per cent vdc. During normal operation, a-c input power is converted by a battery charger to direct current which supplies the inverter. A battery (60 lead-acid or 92 nickel-cadmium cells) is floated on the input to the inverter. When a-c power fails, the battery supplies the inverter without interruption in the latter's a-c output. No lubrication and reduced maintenance are stressed — there are no moving parts. Control circuits are mounted on roll-out chassis, as demonstrated by model in photo.

33—Rectangular panel meter has all-metal construction

These 4-by-6 in. rectangular meters of Helipot Div., Beckman Instruments, Inc. are of all-metal construction with steel movement enclosures for protection



What makes the first gear-type coupling still first choice?

Check design . . . and you'll find Fast's Couplings (the original gear-type couplings) are superbly engineered, ruggedly built, smoothly running units designed to outlast the machines they connect.

Check completeness of line . . . and you'll find Fast's Couplings come in a complete range of sizes and types for shafts from ½" to 32" and larger.

Check service . . . and you'll find Fast's Couplings are backed by expert help from experienced field engineers . . . while outstanding stock facilities throughout the country insure speedy delivery of your coupling orders.

Check popularity . . . and you'll find Fast's Couplings are the choice of more industrial equipment manufacturers than any other shaft coupling.

Check Fast's for your coupling needs today.

KOPPERS COMPANY, INC., 1205 Scott St., Baltimore 3, Md.

KOPPERS

FAST'S COUPLINGS

Engineered Products Sold with Service

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THE LONERGAN LINE

HOW TO SAVE WEAR AND TEAR ON MEN AND VALVES

by A. J. Schmidt, Chief Engineer

Power plant users of relief valves in liquid service are undoubtedly all too familiar with chattering. Valves hammer away, annoying plant personnel and running up maintenance bills.

Even with this undesirable operation, these

valves have been acceptable for application where the valves are seldom, if ever, called upon to relieve. For use under critical applications, such as pump-by-pass, where the valve is normally open, or where opening is a common occurrence, it has been necessary to use expensive diaphragm or piston operated valves to eliminate objectionable chattering.

A new series of valves, called Lonergan Hydro-Valves have been under test in dozens of leading plants for the past three years. As a result, Lonergan can provide power plant operators with a valve that is guaranteed not to hammer, chatter or drum on any application, by-pass or emergency relief. At the same time, full-rated liquid flow is maintained. The chatter free operation is provided by a patented, unique design of throat, seat and baffle construction. Use of the Hydro-Valve helps to: save human nerves; prevent loss of plant fuel or product; reduce maintenance on valves and piping; and eliminate interference with delicate control systems. Hydro-Valves are available in all regular body and trim materials in sizes ranging from 1 to 8 inches.

Full details and descriptions are available in our new Hydro-Valve bulletin. Why not write for your copy today?

Alvin J. Schmidt

Lonergan

J. E. LONERGAN CO., 207 RACE STREET
PHILADELPHIA 6, PA. SINCE 1872

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It's NEW for HEAVY-DUTY SEWAGE USES

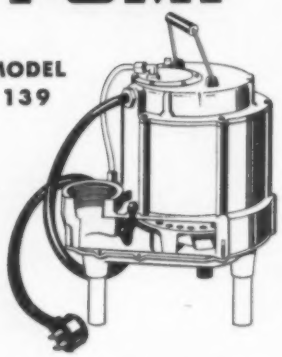
KENCO®

HIGH CAPACITY 8600 GPH at LOW HEAD 5 ft. Head

6800 GPH at 10-ft.

PUMP

MODEL 139



- Completely Submersible
- Rugged Cast-Bronze Construction
- Extra-Deep 2-Vane NON-CLOG Impeller
- 2" NPT Discharge
- Extra Powerful Pumping Action
- Shreds sewage and other solids for dependable non-clog performance
- Leg supports—threaded to use any standard ½" pipe for readily adjustable stand

See Your Wholesaler

A-3068A

KENCO PUMP

Division of The American Crucible Products Co.

1305 Oberlin Avenue • Lorain, Ohio

against effects of magnetic panel materials or stray RF. They are gasket sealed to keep moisture, dirt and foreign particles out. Scale length is 4.7 in. for maximum visibility and reading ease. Meter mounting configuration matches other meters of similar size. Standard meter finish is black.

34—High visibility vest guards those who should be seen

This vest is made of brilliant flame-red fluorescent vinyl-coated nylon. It's offered by Safety Equipment Co. for wear by anyone working in locations

where being seen is important to safety, as on highways. The vest is light in weight, designed not to hamper movement in any direction. One size fits all.

35—Molded case breakers, 100 amp, require less mounting space

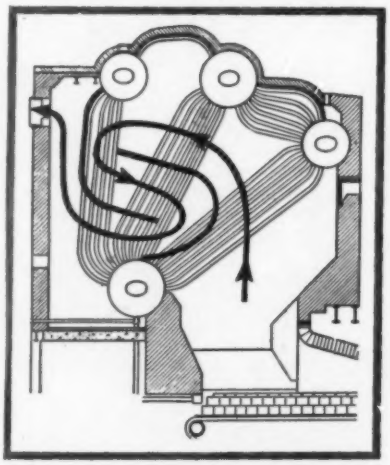
Substantial cost- and space-savings are provided by these 100-amp two- and three-pole molded case circuit breakers, announced by I-T-E Circuit Breaker Co. as the smallest available for use as main breakers. Designated EQ-P (for plug-in connection) and EQ-B (for bolt-in connection), the breakers can replace larger E-frame units formerly used when 100-amp ratings were required. Only 2⅞ in. high and 2 in. (two poles) or 3 in. (three poles) wide, these breakers reduce mounting space requirements by

as much as two-thirds. A three-pole EQ-P (shown at right) requires only 8⅝ sq. in., as compared to 27 sq. in. for the E-frame unit. Expanded handles running the width of the breaker, give extra gripping area for easier manual operation; they also span and thus show the poles operated by each breaker handle in a panelboard, preventing possible confusion of the breaker poles during installation.

These important fuel-saving, maintenance-reducing features are obtainable with Enco boiler baffles — *and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottle necks**
- **Reduced draft losses**
- **Higher heat transfer**
- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.



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Construction News

continued from page 91

a line Texas Electric Service will build from Fort Worth southwestward to the Permian Basin area of West Texas, and a line Texas Power & Light will build from Dallas, northward to the Red River. The line will link generating plants with a combined capacity of 6,500,000 kilowatts. Construction of the project is planned for the early part of 1962.

Newman, Texas — El Paso Electric Co, 213 North Stanton St., El Paso, Texas, has announced plans which have been approved for a major expansion of its generating station located here. Plans call for the installation of a second generating unit with an initial capacity of 90,000 kw, doubling the Newman Station capacity and bringing the utility's total capacity to 443,000 kilowatts.

San Antonio, Texas — City Public Service Board, San Antonio, Texas, 145 Navarro St, this city, has authorized plans to install a 165,000-kw turbine-generator in municipal W. B. Tuttle Power Plant, located here. Work will include installation of high-pressure boilers and auxiliary equipment, and will begin soon.

Seattle, Wash. — Puget Sound Power & Light Co, Stuart Bldg, this city, has announced plans to erect a new power transmission line from Wenatchee to Auburn, Washington, a distance of 131 miles. A new receiving station is also planned and will be erected at the Auburn end of the line. Work will not begin until the early part of 1962 and will be completed in about 18 months. Cost of the new line installation will be approximately $7,000,000.

Casper, Wyo. — Pacific Power & Light Co, Public Service Bldg, Portland, Oregon, has announced contract award of $3,500,000 to the Jelco Co, Inc, Salt Lake City, Utah, and Union Power Construction Co, Denver, Colo., for the construction of a 58-mile high-voltage transmission line from Casper to Riverton, Wyoming, and a transmission line 53-miles long between the two cities. Work on the project will get under way at once and is scheduled for completion by the summer of 1962.

ANSWER
to Worthington Hidden Value Puzzle

The fictitious "hidden value" on the back cover is, of course, the "Full Floating Wrist Pin" in the piston. This construction is found only on light duty compressors with single acting cylinder construction.

Because all Worthington horizontal compressors are heavy duty machines, they are built with the crankshaft, connecting rod and crosshead linkage system illustrated above. It changes rotary shaft motion to linear piston motion without side thrusts on the cylinder walls. Thus wear is reduced and compressor life increased. Worthington Corporation.

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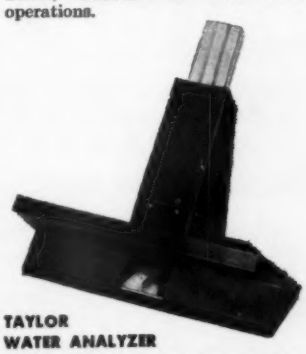
(I didn't buy a Taylor Comparator the *first* time.)

I thought comparators were pretty much the same, but was *I* wrong. Broke two of those fragile, individual glass standards the first week . . . and things were really fouled up. Got a Taylor Comparator as soon as I could . . . and I'm really sold on Taylor. You can't beat a slide with the color standards right in it for convenience and easy use.

Taylor Comparators—with guaranteed non-fading color standards in a single slide—let you make fast, easy, accurate tests for pH, phosphate, chromate, sulfite, hydrazine, nitrate, etc. . . . right on the spot. You get dependable data to help you control boiler, condenser or water tower operations.



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when YOU buy a boiler

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Specify all these features now and avoid wishing you had later

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   If you settle for less, you may find yourself playing that old army game known as "passing the buck".

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   You'll be pleasantly reminded of its efficiency and operating economy every time you pay a fuel bill.

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   Requires no tall expensive chimney, no special foundation other than a floor which will support its weight.

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   Check its weight. It's heavier . . . built for that long-lived operation which generates owner satisfaction.

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   Designed for any liquid or gaseous fuel, and supplied with burners and controls to suit your own operations.

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Commercial Literature

Power Engineering

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Ventilating, Refrigeration and Air Conditioning

201 Industrial Fans — Fundamental data on industrial fans incorporating a universal discharge are presented by Lehigh Fan & Blower Div. of Fuller Co. in 28-pp Bulletin L-5. Included are rating tables giving volumes of air delivered, rpm, horsepower at various static pressures, and outlet velocity and velocity pressures, as well as tables of correction ratios.

202 Centrifugal Fans — Catalog 1120-1 of Westinghouse Electric Corp. contains 76 pp of detailed information on all-purpose centrifugal fans with flat, backwardly inclined blading, suited for supply and exhaust, general building ventilation, industrial air conditioning and processes. Key components and features illustrated, performance data tabulated.

203 Ventilation and Cooling — Basic principles of ventilation and cooling and definition of American Coolair Corp.'s "breeze conditioning" are presented in 8-pp Form 349. Typical applications in industry are detailed and figures on calculation of air volume required are given.

204 Air Conditioning Equipment — Featured in this product bulletin by Drayer-Hanson Div., Hi-Press Air Conditioning of America, Inc., are fan coil units, central station air handling units, multizone air handling units, sprayed coil dehumidifiers. Also shown are hot-cold deck high pressure units, heating and ventilating units, evaporative condensers, air cooled condensers, coils, cooling towers.

205 Plastic Ventilating Equipment — Illustrated and described in 18-pp Bulletin B-500 are plastic ventilation products of Heil Process Equipment Corp. including ventilating ducts, fittings, exhaust hoods, stacks, covers, fans, and fume scrubbers. Physical and chemical properties of glass-reinforced plastics given.

206 Air Engineering — Bulletin E-57, is a 24-pp air engineering data file, offered by Aerovent Fan Co., Inc. Covers engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses provided.

207 For Controlled Ventilation — This 20-pp catalog of The Loren Cook Co. is designed as a guide in determining exact type ventilation equipment for specific needs. Guide matches design features with ventilation requirements and special conditions, controlling efficiency, and economy and lengthening life of unit.

208 Air Conditioning Units — Detailed information on a packaged central station air conditioning unit designed by American Air Filter Co., Inc. to give exact type and degree of air cleaning is presented in 60-pp Bulletin AC-100. Component features are illustrated, and selection data including psychrometric calculations, size selection, arrangement and location, air volume and velocity data, air resistance data given.

209 Packaged Air Conditioners — Performance characteristics and engineering features are detailed in color-illustrated Bulletin 8825, 12-pp, from American-Standard Industrial Div. Typical installation photos showing units with and without discharge plenum are included to illustrate a discussion of owner advantages.

210 Conditioner Units — Design features of Climate Makers, based on the building block principle, are detailed by Airfan Engineering Co. in 60-pp Catalog AHV-59. Gives fan capacities, direct expansion cooling capacities, and coil data, chilled water cooling capacities, chilled water coil data, mean effective temperature, psychometric data.

211 Coil Selection Guide — Information on Young Radiator Co.'s water and direct expansion refrigerant coils is given in 28-pp Catalog 5559. Provides selection data on water heating and cooling coils; physical and performance charts; mean effective temperature difference charts. Also includes capacity tables, psychrometric chart, total heat table.

212 Air-Cooled Condensers — Four types of air-cooled condenser units are discussed by Halstead & Mitchell in 12-pp Bulletin AC-102 — those using propeller fans for horizontal air flow, propeller fans for vertical air flow, centrifugal fans for use with ductwork, and centrifugal fans.

213 Refrigeration Condensers — Engineering data on refrigeration condensers are featured by Henry Vogt Machine Co. in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, freon condensers, condenser-towers.

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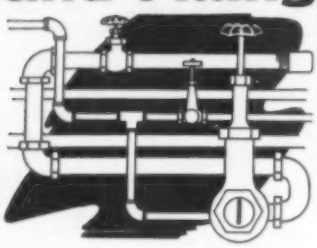
214 Cold Room Conditioning — In Bulletin 95, Niagara Blower Co. describes the No-Frost method of producing temperatures down to −90 F for freezing, testing, cold storage etc., giving advantages. Operation with two-stage and three-stage cooler discussed.

215 Refrigerated Purging Guide — In 12-pp Bulletin 700, Armstrong Machine Works gives helpful data on automatic removal of air from refrigeration systems. Tells why purging is necessary, how non-condensable gases affect efficiency, methods of purging, where to make purge connections and how to use the purger.

Piping, Valves and Fittings



216 Valve Selection Tips — In addition to cross indexing company's own line of valves with those of other manufacturers, The Ohio Injector Co.'s Valve Buyer's Guide, 22 pp, contains a list of frequently used abbreviations, a valve trim chart, other data. A breakdown by valve material and pressure class, and classification by type, disc design, etc., aids in selection.

217 Valve Selection Data — Facts to keep in mind when selecting a valve for a specific application are detailed in Crane Co.'s 20-pp Bulletin AD-2016. Three principal valve types are illustrated and described, and cutaway views showing component features included.

218 Valve Materials Calculator — Preferred valve materials for different types of corrosives are shown in this calculator prepared by Hoke, Inc. It is designed as a guide to the selection of materials of valve construction, based on "substantial," "moderate," "questionable" or "inadequate" resistance to a chemical at atmospheric pressure temperature.

219 Check Valves — Details and specifications on check valves designed to eliminate water hammer and line surge are presented by Combination Pump Valve Co., in 20-pp Catalog 600. Typical installations are illustrated, and installation data, flow chart, and ratings included.

220 Silent Check Valves — Described by The Williams Gauge Co., Inc. in Bulletin WH-654 are silent check valves featuring low frictional resistance. Tables list dimensional data and reasonable velocities for flow of water through pipe, fitting, and valves.

221 Butterfly Valves — Illustrated and described by Henry Pratt Co. in Bulletin 10 EA is a line of rubber seat butterfly valves designed to mount between pipe flanges. Complete specifications, certified dimension drawings, water flow data, gas flow data, weights and freight rates, and prices are included.

222 Control Valves — Steam and liquid control valves manufactured by O. C. Keckley Co. are illustrated and described in 56-pp Catalog 58-A. Covers strainers, pressure regulators, temperature regulators, safety and relief valves, pressure reducing valves, diaphragm control valves, solenoid valves, float valves, others. Includes capacity tables, specifications, cutaway views.

223 Relief Valves — Bulletin V-100/60, 24-pp, describes J. E. Lonegran Co.'s line of bellows valves for vapor service. It gives complete details and specifications on sizes, capacities, materials and other pertinent data. The seven exclusive features of this valve are also listed.

224 Stock Solenoid Valves — Solenoid valves available "off the shelf" from Automatic Switch Co. are presented in 16-pp Stock List and Selection Guide 506. Contains engineering information, simple selection data, illustrations and flow diagram of two-, three- and four-way types, manual reset valves, special valves.

225 Specifying Solenoid Valves — Included in Valcor Engineering Corp.'s 8-pp booklet on specifying solenoid valves are a description of various types of valve sealing; a discussion of mechanical specification criteria including application description, fluid characteristics, pressure, capacity, leakage, valve life.

226 Safety-Relief Valves — Liquid relief and special service safety-relief valves, including a new, low cost compact series, are presented by Farris Engineering Corp. in 28-pp Catalog FE-138. Valves shown include types for hydraulic pressure systems, liquefied gases, chemical corrosive service and general industrial service.

227 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of Everlasting Valve Co.'s quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions.

228 Valve Operator — Applications and features of Crane Co.'s Converto-Gear Operator designed to fit wide variety of Crane iron and steel gate valves, 2½ in. or smaller, are detailed in Form AD-2441. Dimensional data are included.

229 Steam Traps and Vents — Lecture 1A on "Steam Trapping and Air Venting" is offered by Sarco Co., Inc. as a comprehensive treatise on all types of steam traps. Describes operating principle and construction of each of the recognized steam traps as a guide to selection.

230 Steam Traps — This Condensed Catalog of Sarco Co., Inc. contains 12-pp of technical details, dimensions, and capacity data on steam traps, temperature regulators, and heating specialties. Cutaway views and diagrams are included.

231 Steam Traps — Details on Marsh Instrument Co.'s float and thermostatic traps, inverted bucket trap, boiler return trap, air traps, and strainers are offered in 16-pp Section 12. Gives roughing-in dimensions and capacities along with construction views.

232 On Steam Traps — Catalog K is an enlarged 48-pp manual and steam trap catalog of Armstrong Machine Works. New material provided includes open float and thermostatic traps, pipe strainer to 6 in. steel and semi-steel, and helpful steam pipe sizing tables. Discusses fundamentals of trapping, trap selection, installation.

233 Manual on Traps — This 40-pp engineering manual published by the V. D. Anderson Co. is designed to assist in the sizing, specifying and selection of steam traps and other fluid specialties. Includes steam trap selection guide, explanation of four basic types of traps and how they perform their function, four steps to follow in sizing a steam trap, table of factors and detailed instructions on selection.

234 Thermostatic Radiator Traps — Construction and operation features of thermostatic radiator traps and float and thermostatic traps manufactured by Sterling, Inc. are described in Bulletin 102. Includes diagrams, roughing-in dimensions and capacity tables.

235 Guide to Strainers — Presented by Tate Engineering, Inc. in this 88-pp handbook are reference data for layout of fluid flow systems and sizing of strainers, tabulated results of testing, and valve and pipe selection information. Reference material for each strainer section is on a fold-out page for use with any specific page in that section. Book contains over 100 illustrations of pressure drop, temperature, and viscosity charts, also engineering drawings.

236 Plastic Pipe, Fittings — PVC pipe, valves and fittings and their uses are covered in this 36-pp handbook by Kraloy Plastic Pipe Co., Inc. Specification, design and installation data are included, as well as a comprehensive corrosion resistance comparison chart of seven types of plastic pipe carrying 162 chemicals.

237 Good Piping Charted — Recommended piping practices are presented in this wall chart form by The Lunkenheimer Co. Chart is divided into five sections covering basic valve types, connections normally used, installation and maintenance tools, installation, operation and maintenance.

238 Materials for Main Stream Piping — Entitled "The Plastic Ductility of Austentic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin of Pittsburgh Piping and Equipment Co. deals with an investigation into the problem of selection of materials for main stream piping. Gives stress rupture characteristics of Type 316 and 347 stainless steel piping adjacent to welded joints.

239 Power Piping Erection — Field erection of high-temperature, high-pressure power piping is the topic of this 12-pp bulletin released by The M. W. Kellogg Co. Illustrated with photos and diagrams, it shows how detailed plans are developed, field-erection costs and quality control.

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240 Pipe Thread Fittings — Advantages of pipe thread fittings designed to eliminate positioning problems, leakage, and overtightening damage are detailed by the Tru-Seal Div. of Flick-Reedy Corp. in this product bulletin. Common types of positioning distortion, alignment reworking and leakage problems and their solutions are illustrated.

241 Ball Joints — How to provide for movement and flexibility in metal piping with simple ball joints is detailed by Barco Mfg. Co. in eight-section Catalog 250. Illustrations of the five basic motion principles of ball joints serve to explain safe flexibility in piping subject to contraction and expansion.

242 Supports for Piping — Described in 96-pp Catalog 59, is a system utilizing pre-engineered standard components in almost infinite combinations to solve most piping and equipment support problems. The system, introduced by Bergen Pipesupport Corp., affords savings in engineering and field costs, offers simplicity of use. Book also gives details on constant support hangers; roller devices; variable supports, hangers.

243 Pipe Alignment Guide — This bulletin of The Align-O-Pipe Guide Co. introduces a device for guiding pipe lines which are expanding or contracting because of temperature changes. Explains how units permit movement of pipe line in an axial direction only.

248 Insulation Specifications — In this set of six specifications, Pittsburgh Corning Corp. covers applications of Foamglas insulation for industrial equipment and piping. Each booklet contains tables of suggested thicknesses of insulation to be applied, drawings of insulation procedure, supports and recommended finishes. Booklets are devoted to low-, medium-, high-, and dual-temperature equipment, to underground piping.

249 Insulating Materials — Properties and specifications of over 30 insulations for service from sub-zero to 1900 F are presented in this 24-pp 1960 catalog of Baldwin-Ehret-Hill, Inc. Spun mineral wool, calcium silicate and 85 per cent magnesia products in block, blanket, felt, fill cement, and pipe insultation are described. Thermal conductivities and tables of recommended thicknesses are given.

250 Molded Pipe Insulation — Characteristics and advantages of Johns-Manville's Fibrocel molded pipe insulation are detailed in this 8-pp product bulletin. Includes specifications for heating and plumbing piping.

251 For Insulation Protection — Comprehensive data on mastics, coatings, adhesives, and flashing compounds for thermal insulation has been classified as to industry usage — power, process, cold storage, marine and commercial — in this ready-reference loose-leaf manual, about 208-pp, of Benjamin Foster Co. Detailed application data included.

Insulation

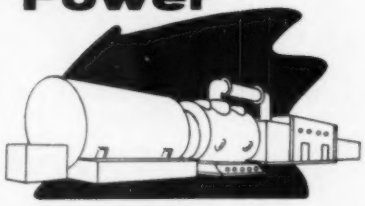
244 Thermal Insulation — Described in 54-pp Catalog IN-244A are Johns-Manville thermal insulations for all types of commercial and industrial requirements from −400 to 3000 F. Contains six sections, each devoted to a specialized group of insulations, including industrial and high temperature; plumbing, heating and air conditioning; refrigeration; insulating firebrick and refractories.

245 Insulation Specifications — Johns-Manville's 50-pp manual of specifications, IN-128A, is designed for power, chemical and petroleum industries. It is divided into five sections—insulations for temperatures above 100 F; those for temperatures below 100 F; tank insulation; sphere and spheroid insulation; regenerator, catalytic reactor and oil heater lining and insulation. Tables include recommended thicknesses for both steam generating plants and process equipment.

246 Thermal Insulation — This 16-pp bulletin released by National Insulation Manufacturers Association is designed to serve as a guide to best use of thermal insulating materials under changing conditions of modern industry. Emphasizes "economic thickness" approach to specification, which enables determining point at which insulation gives greatest financial return for its cost.

247 Pipe-Fitting Insulation — Design features and advantages of an improved molded Fiberglas pipe fitting insulation are detailed by Fibrous Glass Products, Inc. in Bulletin TD-105. Specifications included.

Motive Power



252 Large Generating Units — Design and construction features of large steam turbine generating units are illustrated and described in 40-pp Bulletin 03B9448, Allis-Chalmers Mfg. Co. Subjects covered range from compact component design to controls and instrumentation. Illustrated with photos, drawings and section diagrams. Includes ratings.

253 Steam Turbines — Advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined by The Terry Steam Turbine Co. in illustrated Bulletin S-140. Describes various models in their line and includes application photos.

254 Gas Turbine Engines — Featured in this 24-pp bulletin of Solar Aircraft Co. are engine data, performance curves and applications for gas turbine engines. Explains operation of gas turbines and includes application photos.

255 Industrial Gas Turbines — Versatility of General Electric Co.'s gas turbines as a power source for a variety of industrial and other applications, including power for emergency generator sets, is detailed in 16-pp Bulletin GED-5685. Includes review of engine specifications.

256 Gas Turbines — The power concept of The Cooper-Bessemer Corp.'s gas turbine based on the J-57 jet engine is discussed in 8-pp Bulletin 95. Describes operating characteristics, thermal efficiencies, maintenance costs, and potential applications, and includes schematic drawings, performance curves.

When ordering catalogs, allow time for us to relay your requests to the manufacturers — and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

257 Industrial Gas Turbines — Advantages and economies of industrial gas engines made by Orenda Engines Ltd. for general industrial and other applications are outlined in this 24-pp bulletin. Performance data and curves, dimensions, operating costs curves, heat recovery data and other information included.

258 Gas Turbines for Peaking — Peaking combustion gas turbines with capacities from 7,000 to 28,000 kw are described in 12-pp Bulletin GED-3761, General Electric Co. Outlines savings possible through lower installed cost, minimum space and personnel requirements, less transmission equipment investment, lower line losses.

259 Gas Turbine Power — Eight-pp Bulletin GEA-7083 of General Electric Co. introduces a line of 75 to 20,000-hp ultra-lightweight, compact gas turbines for a wide variety of applications, including fluid and gas pumping, electric power generation. Covers design features, performance and operating characteristics.

Dust Control

260 Electronic Air Cleaner — Twelve-pp Bulletin 405, Dollinger Corp., describes features and advantages of an electronic air cleaner based on the principle of electrostatic precipitation. Diagrams, photos, specifications included.

261 Mechanical Dust Collectors — Recent improvements in mechanical dust collectors including a new involute design are described in 8-pp Bulletin 300 of Research-Cottrell, Inc. Contains detailed drawings and application diagrams.

262 Dust Collection, Recovery — Details on dust collecting, recovery and classifying equipment manufactured by Buell Engineering Co., Inc. are presented in this product bulletin. Covers electric precipitators, mechanical collectors, bag collectors, and combination systems.

Postage-free Reader Service Cards are on pages 103-104

Boilers and Auxiliaries

264 Steam Generators — Automatic packaged steam generators manufactured by Ames Iron Works, Inc. are featured in 18-pp Bulletin AA 2760. Analysis of boiler design factors is included along with detailed performance data, photos and a longitudinal section.

265 Bent Tube Boilers — Design and operation features of bent tube boilers manufactured by Henry Vogt Machine Co., Inc. for power, processing or heating are detailed in 22-pp Bulletin VF-VS-2. Boiler sections of typical installations and principal data on each are included.

266 Automated Boilers — Pros and cons of automated boiler operation are set forth in 12-pp Bulletin G-101 of The Babcock and Wilcox Co. Originally an ASME-AIEE Power Conference paper, this informative study treats current status and future of boiler automation. Covers computer programming, methods of automation, flame detection and burner control, weak links, significant design innovations.

267 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators. Published by Crane Co.'s Cyclotherm Div., it tells how installation of a package steam generator can raise steam capacity in an existing boiler room.

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268 Automatic Boiler — Application of the Coal-Pak automatic package boiler to low-pressure steam heating, hot water heating, and high-pressure process steam is covered by Bituminous Coal Institute in 36-pp Guide Specifications GS-3. Sample specifications included, coal and ash handling, wiring, and boiler room layouts.

269 Hot Water Boilers — Twenty-pp Brochure HCC-2 of Combustion Engineering Co., Inc. describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler. The unit is for supplying high pressure, high temperature water for heating and process uses.

270 Packaged Boilers — A complete discussion of firetube boilers — from construction features to final test and start-up service — is presented in 12-pp Bulletin Form AD-178, Cleaver-Brooks Co. Full-color cutaway features of packaged boilers through 600 hp for heating and processing, steam or hot water.

271 Boiler Check List — This check list offered by Cleaver-Brooks Co. is designed to give tips on keeping a boiler clean and operating efficiently. Tells how to rate boiler and obtain better performance.

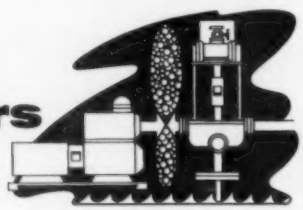
272 Boiler Piping Hook-Ups — Facts about right and wrong piping hooks up, testing, trouble shooting and replacements are covered in Bulletin M-88, a 20-pp pocket guide prepared by McDonnell & Miller, Inc. Generously illustrated, gives examples of abnormal conditions and tells what to do to correct them.

273 Heat Exchangers — Shell and tube heat exchangers, including copper base alloy, steel and stainless steel fixed tube bundle heat exchangers, are described by The Young Radiator Co. in 16-pp Catalog 1258A. Includes pressure ratings and material specifications for steam service heat exchangers, selection data.

274 Heat Transfer Equipment — Design and construction features of heat transfer equipment are detailed in 20-pp Bulletin HE-8 of Henry Vogt Machine Co. Covers the positive seal baffle, film type heat exchangers, waste heat boilers, high pressure and high temperature heat exchangers, exchangers of special alloys.

275 Air-Powered Blowers — Bulletin 1067 describes air-powered rotary soot blowers made by Copes-Vulcan Div., Blaw-Knox Co. Includes external and sectional views of the soot blowers, as well as diagrams showing method of removing soot blower head and element from boiler.

Pumps and Compressors



276 Power Plant Pumps — Bulletin BJP-588, Byron Jackson Pumps, Inc., describes standard pumps for all power plant requirements — from 12,000 hp, double-case boiler feed pump, to condensate, circulating and booster pumping duty. Also describes special pumps for nuclear power plant installation.

277 Vertical Turbine Pump — Featured by Worthington Corp. in 16-pp Bulletin 2400-B1 are ultra high flow vertical turbine pumps. Design improvements, which result in broader coverage and higher efficiencies over wider operating ranges, are illustrated and described.

278 Submersible Pump — Illustrated and described in this 10-pp builetin are applications for submersible pumps manufactured by Kenco Pump Div., The American Crucible Products Co. Lists physical dimensions, pumping capacities, electrical data and detailed specifications.

279 Rotary Air Pumps — Catalog 460, 32 pp, of Leiman Bros., Inc., describes rotary positive air pressure and high vacuum pumps, gas boosters and air motors. Gives construction details, dimensions, capacities, performance curves for all pumps, plus engineering data.

280 Controlled Volume Pumps — How to choose the right controlled volume pump for the application is told by Milton Roy Co. in Bulletin 553-J. Gives data on standard motor driven pumps, models for corrosive liquids, for economy operation, for minute capacity, for uniform linear flow, other special types.

281 Simplified Pump Selection — Technical data is simplified and presented in an easily-understood way in the Deming Co.'s rotary pump selection manual. Groups liquids according to viscosity and each classification has its own selection table. Fast selection is possible by matching liquid to pump.

282 Free-Piston Pumps — Features and advantages of an air-operated free-piston pump designed to pump anything that flows are detailed by The Crossley Machine Co. in this product bulletin. Sequence diagrams show operation.

283 Proportioning Pumps — Featured in this product bulletin by The Bird Archer Co. are proportioning pumps and package chemical feeding units. Detailed specifications and application chart.

284 End Suction Pumps — Described in Bulletin 158 are horizontal shaft, single stage, and suction pumps designed for handling abrasive mixtures and slurries, as well as corrosive and hot liquid. Various models on the line are described as to design and application by Nagle Pumps, Inc.

285 Rotary Vacuum Pumps — Features of Consolidated Vacuum Corp's oil sealed rotary vacuum pumps are detailed in 6-pp Bulletin 8-15. Discusses building block construction, ease of maintenance of these pumps, includes selection suggestions. Dimensions, physical specifications and speeds and capacities given.

286 Pump Selection Catalog — Included in 12-pp easy-to-use Circular 184 of Dean Brothers Pumps Inc. are charts showing recommended temperature and pressure ranges for 10 classifications of company's pumps — from −350 to +1000 F, and up to 1000 psig. Illustrations, descriptions and specifications are shown.

287 Pumps and Controls — Bulletin 220 contains 72 pp of data on design details and operating characteristics of hydraulic pumps, fluid motors and valves offered by Dennison Engineering Div., American Brake Shoe Co. Sections are devoted to types of hydraulic pumps, pumping units, fluid motors, and control valves, covering design and operating characteristics of components.

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288 Sizing Cooling Tower Pumps — Six steps to be taken in sizing pump and piping of any cooling tower installation are explained by Bell & Gossett Co. in 6-pp Bulletin CT-360. Provides selection charts, pipe sizing tables.

289 Pumping and Hydraulic Data — Definitions, formulae, testing, tables, charts and definitions useful in pumping and hydraulics are covered in 20-pp Bulletin EM-77 issued by Peerless Pump Div., Food Machinery and Chemical Corp. Includes facts on how to figure NPSH, pump efficiency, mechanical and electrical equivalents, and pipe friction loss chart.

290 Heavy-Duty Compressors — Twelve-pp Bulletin A-73 covers heavy-duty industrial air compressors, providing specifications and dimensions for six basic models from 350 to 1250 hp, 2418 to 7392 cfm available from Joy Mfg. Co. Semi-radial design features are shown in a large cross-section drawing. Installation photos point up compactness of the unit.

291 Compressed Air Fundamentals — Sixteen-pp Form 1548, Ingersoll-Rand Co., is intended to aid in selection of a small "packaged" air compressor. Discusses compressed air, how it is compressed, single- and two-stage compressors, piston displacement, control used etc. Includes information on compressor oils, pipe sizes, wire sizes, terminology.

292 Compressor Data — Feather valve compressors from 75 to 350 hp are described by Worthington Corp in 32-pp Bulletin 3620-B1. Advantages on installation, operation and maintenance costs are outlined for types YC and DYC compressors. Information and illustrations are offered on component parts ,including frame, running gear parts, intercooler, crosshead, motor and main bearings are included.

293 On Eliminating Explosions — In 12-pp Bulletin 173, Clark Bros Co., presents recent findings on mechanism of explosions in pipelines and compressor starting air lines. Discusses research in nature of explosions and shock waves in piping, and these observations are applied to compressor air starting systems.

Lubrication

294 Turbine Lubrication — Basic lubrication requirements for turbines and gears are detailed by Murray Iron Works in Bulletin T-125-A. Sections cover care of the oiling system, turbine lubricants, lubricating oil recommendations, reduction gears and geared units.

295 Lubricant Data — Characteristics, advantages of specialized fluid and grease type lubricants are described in 32-pp Data Book 59-2, by Lubriplate Div., Fiske Bros. Refining Co. Includes sections on control of friction, use of grease type lubricants, proper applications, and recommendations for various conditions.

296 Solid Lubricants — Theory and practice of lubrication by solids are discussed in 24-pp Bulletin 124 by The Alpha-Molykote Corp. Tells advantages of molybdenum disulfide solid lubricants.

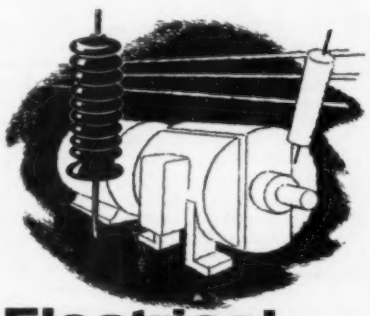
297 Organized Lubrication — Benefits of organized lubrication are extolled by Texaco, Inc. in this 24-pp bulletin. Cost control opportunities are detailed, and task of assigning responsibilities in an organized lubrication system are discussed.

298 Turbine Oils — Characteristics and advantages of Gulf Oil Corp.'s turbine lubricating oils are detailed in 8-pp Bulletin SP-8878. Performance figures given.

Cooling Towers

299 Cooling Tower Economies — Presented by Hamon, Inc. in this 12-pp bulletin is a discussion of economic comparisons on cooling towers for a utility. Compares natural draft and mechanical draft towers to various approaches and includes detailed cost comparison curves.

300 Cooling Towers — Performance details on cross-flow cooling towers of The Marley Co., are presented in this 20-pp illustrated Booklet CF-59. Discusses and illustrates through diagrams the cross-flow principle of water cooling; describes equipment, engineering and design features.



Electrical

301 Induction Motor Selector — Selection, application and buying information on General Electric Co.'s Tri-Clad '55 motors, single- and three-phase, from ¾ to 150 hp is given in 14-pp Bulletin GEC-1049. Includes chart for various loads and ambient conditions, tables for dimensions, prices, characteristics and performance data, ordering instructions, modifications.

302 Motor Selection Guide — This pocket-size card (GED-3909A) provides quick reference to frame size (182 to 445U) and book price for General Electric Co.'s a-c motors from ¾ to 125 hp. Data are tabulated for both drip-proof and totally enclosed fan-cooled Tri-Clad '55 squirrel cage, horizontal motors.

303 Motor Application Guide — Sixteen-pp Bulletin 270B outlines characteristics of Century Electric Co. motors of 1/20 to 400 hp and includes up-to-date design information on them. Discusses factors in motor selection and provides illustrated charts covering a wide range of motor-using equipment.

304 Synchronous Motors — Advantages of The Ideal Electric & Mfg. Co's high speed synchronous motors are detailed in 12-pp Bulletin 501. Cutaway view illustrates component parts and details of maintenance and operation.

305 Submersible Pump Motor— Eight-pp Bulletin F-2000, U. S. Electrical Motors Inc. contains full-length cutaway drawings showing construction details, features of submersible motors for 6-, 10- and 14-in. well diameters and explains their water-filled operating principle.

306 Pump Motors — This 34-pp brochure of U. S. Electrical Motors Inc. consists of a collection of technical articles on pump motors, illustrated with charts, diagrams, graphs, tables, and cutaways. Subjects range from turbine pump motor lubricants, pump motor bearings, to pumping stations and sound control, and steps in submersible installations.

307 Shielded A-C Motors — Comprehensive 56-pp Catalog 200, Sterling Electric Motors, Inc., includes complete dimensional, selection and application data on Multi-Shielded a-c motors. Includes information for various modifications, such as specialized mountings.

308 FHP Motors — Twelve-pp Bulletin GEA-6424A discusses features and advantages of General Electric Co.'s fractional horsepower, Form G, general purpose motors, including capacitor-start, split-phase, permanent-split capacitor, shaded-pole and polyphase motors.

309 Wire and Cable Data — These composite, color-coded data sheets contain information formerly found only in many catalogs on wires, cables and power cords. Prepared by Continental Copper & Steel Industries, Inc., data sheets give prices, stranding, strand diameters, temperature ratings, weights, overall diameters.

310 Portable Cords, Cables — Specifications and characteristics of various portable cords and cables are presented in this 52-pp booklet of Kaiser Aluminum & Chemical Sales, Inc. Gives pertinent data on insulation and jacket compounds, and includes tables giving properties of 600-v portable cables, also 601-5000-v portable cables, and others. A section is devoted to splicing and patching.

311 Cable Splicing Fundamentals — Illustrated with step-by-step photos, this 30-pp booklet of The Okonite Co. explains procedure for splicing and terminating rubber-Neoprene cables, shielded and unshielded. Also includes tape selector and quantity estimating charts.

312 Rigid PVC Conduit — Applications of rigid polyvinyl chloride in the electrical field are detailed in this 20-pp bulletin released by Kraloy Plastic Pipe Co., Inc. Included are comprehensive test results, specifications, installation instructions, corrosion-resistance charts.

313 Why Plastic Conduit — Advantages of using plastic conduit in a variety of electrical applications are detailed in this 6-pp bulletin of Southwestern Plastic Pipe Co. Mechanical, physical and electrical properties and other data are tabulated and installation discussed.

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314 Unit Substations — Comprehensive Workbook PSG-6001, 24-pp, aids in planning articulated unit substations for secondary distribution, and features a suggested specification form detailing data for a properly coordinated substation system. Ratings, weights and dimensions are included. Detailed specifications provided by Pennsylvania Transformer Div., McGraw-Edison Co., for incoming supply sections, transformer sections and outgoing feeder assemblies.

315 Unit Substations — Detailed information on features, operations and application of selectively-coordinated load center unit substations providing continuous power for a-c distribution systems is presented in 32-pp Bulletin GEA-3592L of General Electric Co. Compares types of load center arrangements and explains how selective coordination of load centers can be provided on any of four basic industrial and commercial building power distribution systems.

316 Electrical Distribution — Comprehensive information on electrical distribution products is presented in this 60-pp catalog of I-T-E Circuit Breaker Co. Divided into three main sections covering molded case circuit breakers, individually-enclosed low-voltage power circuit breakers, and engineered products, it contains selection and application data, selection charts listing types, ratings.

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317 Electrical Distribution, Control — Complete with photos, tables of specifications, pricing information, wiring diagrams, this 155-pp reference catalog of Federal Pacific Electric Co. covers 30 types of products. They include circuit breaker load centers, fusible service equipment, enclosed safety switches, low voltage fuses, molded case circuit breakers, enclosed industrial breakers, wall mounted air breakers, bolted pressure contact switches, others. Book is available to qualified power engineers.

318 L-V Distribution Equipment — General Electric Co.'s 84-pp, 1960 Buy Log covers low-voltage distribution equipment. It serves as a condensed buying catalog for service entrance equipment, light and heavy duty safety switches, tumble and open-knife switches, hinged wireway, circuit breakers, switchboards, motor control centers, sectional distribution centers, panelboards and busway.

319 Industrial Power Systems — Principles of planning industrial power distribution systems for safety, reliability and economy while retaining flexibility and provisions for future expansion are outlined in General Electric Co.'s 48-pp Bulletin GEA-7139. Chapters cover choosing voltages, short circuit calculations, protective relaying, substation selection.

320 General Purpose Controls — Catalog 1260D, 72 pp, contains information on general purpose control devices available from General Electric Co. Charts are listed for motors from ¼ through 200 hp, affording quick selection of heaters and push button stations. Product descriptions are provided for both manual and magnetic motor starters, relays, solenoids, limit switches, push buttons, static control and pilot devices. Pricing tables are included.

321 Electric Motor Controls — Contained in 72-pp Catalog 5900 of Furnas Electric Co. are selector charts for magnetic and manual starters, giving horsepower, motor speed, heater size, heater ampere ratings, enclosure choices. Covers manual starters, magnetic controls, drum controllers, pressure switches, others.

322 Reduced Voltage Starter — Eight-pp Bulletin GEA-6860, General Electric Co. defines reduced voltage starters, tells when and where to use them and how to select them. Contains starter selection table and comparison table. Shows the manual autotransformer, magnetic autotransformer, primary resistor.

323 Low-Voltage Switching — Twenty-pp Electrician's Manual RM-610 offered by Remcon Div., Pyramid Instrument Corp., contains an introduction to low-voltage switching. Explains how company's remote-control switching works electrically, how components are mounted, how to plan a layout.

324 Voltage Regulators — Distribution voltage regulator features designed to provide more economical and better voltage regulation are described by Allis-Chalmers Mfg. Co. in 16-pp Bulletin 21B7977E. Describes unit construction, electrical re-settable position indicator, other features.

325 Electric Motor Controls — Pocket Catalog 60, published by Furnas Electric Co., 56-pp, gives descriptions, ratings, prices for manual and magnetic starters, drum controller, pressure, foot and limit switches. Included are push buttons, related pilot devices, motor rating, heater coil data, and selection tables.

326 Interrupting Capacity Chart — This chart, prepared by Westinghouse Electric Corp., aids in selecting and ordering proper circuit breaker for each application. Interrupting ratings, available fault currents covered.

327 Circuit Breakers — Low voltage stored-energy power circuit breakers are discussed by General Electric Co. in a 20-pp Bulletin GEA-5915E. Includes photographs, diagrams, graphs, charts showing specifications, operating features, dimensions, ratings for low voltage power circuit breakers and applications. Manual and electrical stored-energy closing mechanisms are described.

328 Basic Electrical Protection — Ten-pp Bulletin BPB issued by Bussmann Mfg. Div., McGraw-Edison Co. gives information on motor protection, system selectivity to faults, fuse application and fuse selection. Tells how to coordinate opening time of protective device so that a fault current will be isolated to the circuit of origin and includes charts showing time of opening and current limitation.

329 Electrical Equipment Guide — Describing heavy duty electrical transmission and distribution equipment for commercial, industrial and other installations, this catalog digest of Continental Electric Equipment Co. contains detailed specifications. Presents interrupter, switches, medium voltage switchboards, unit substations, power centers, low voltage switchgear, panel type switchgear, bus ducts, bus plugs, motor control centers, panelboards, circuit breakers, others. Available to qualified power engineers, please state your job title.

330 Maintaining Electrical Equipment — Maintenance and inspection practices to foretell and prevent failure for different types of electrical industrial equipment are described by Associated Research, Inc. in 52-pp Manual D-62. Illustrated by graphs, tables and photos, it contains comprehensive data on methods and instruments for voltage breakdown tests and for measurement of insulation leakage at high voltage. Includes procedures for predicting equipment life.

331 Overload Fault Currents — Sixteen-pp Section 7 of an aluminum conductor engineering data series offered by Aluminum Co. of America, discusses overload and fault current limitations of bare aluminum conductors. Includes graphs showing maximum allowable time for various emergency or short circuit currents.

332 Industrial Capacitors — Twelve-pp Booklet B-7642, Westinghouse Electric Corp., answers questions concerning use of capacitors to reduce power costs, increase system capacity, and apply to industry. Subjects cover power factor, benefits of capacitors, how to select capacitors, and where and how to apply.

333 Channel Fittings, Hangers — This pocket-size reference type work manual, about 68 pp, contains product illustrations and correlated information for specifying and using structural support materials for electrical installations. A publication of Steel City Electric Co., it is indexed to sections identified with specific areas of application . . . as for suspending single and multiple runs of conduits; building racks and frames; concrete inserts; beam clamps.

334 Battery Technology — Bulletin GB-1896 is a 36-pp handbook of technical instructions and engineering data on the care of motive power storage batteries offered by Gould-National Batteries, Inc. It covers all phases of lead acid battery theory, operation and maintenance.

335 Battery Chargers — Selenium or silicon rectifier battery chargers designed for station-type batteries used by utilities and industrial plants are described in this product bulletin of Syntron Co. Specifications, data and descriptions of standard models from 15- to 200-amp.

336 Silicon Rectifiers — Booklet B-7900, which tells why silicon rectifier packages offer d-c power saving to the electrochemical and allied industries, is offered by Westinghouse Electric Corp. This 20-pp publication presents detailed description of a silicon power package and states advantages of silicon over other types.

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337 Tungar Bulb Data — Eight-pp Publication ETR-2091, a revised edition of General Electric Co.'s manual on Tungar bulbs, contains typical circuits and operating data. Also provides descriptive and theoretical data on use of Tungar bulbs in rectifier circuits to provide noise-free power supplies with low voltage drop and high efficiency.

338 Testing Instruments — Twelve-pp Bulletin 19-60 contains descriptive information on industrial instruments available from James G. Biddle Co. They include electrical resistance testers, dielectric test sets, cable fault locating equipment, turn ratio test sets, and others.

339 Portable Test Units — Presented in this 48-pp booklet of Multi-amp Electronic Corp. is detailed information on portable test units for protective relays. Subjects treated include classification of relay tests; preparation for protective relay testing; reasons for an adequate testing and maintenance program.

340 Insulation Materials — Illustrated 36-pp Catalog 34 presents electrical insulation for repair and maintenance of motors, generators, and electrical or electronic equipment. Prepared by Insulation Manufacturers Corp. covers packaged insulation products: cotton, asbestos, and woven glass tapes; cotton, glass and varnished or saturated tubing and sleeving; mica plates and laminates; others.

341 Electrical Insulating Oils — Bulletin 58, 6 pp, gives technical information on Sun Oil Co.'s insulating oils for transformers and cables. Discusses functions of a transformer oil; gassing characteristics of oils, properties of electrical oils, uses for inhibited and uninhibited oils.

342 Electrical-Insulating Varnish — This 36-pp catalog of Minnesota Mining & Mfg. Co. covers selection and application of electrical insulating varnishes with complete details on all electrical and mechanical properties as well as operating temperature limitations. Includes charts, graphs and illustrations.

343 Power Supply Handbook — Specifications on regulated d-c supplies, frequency changers (variable frequency power sources) high-voltage power supplies (to 600 kv) and other high-voltage products, miniature transistorized power supplies, inverters and converters, and a-c line-voltage regulators are presented by Sorenson & Co., Inc. in this 32-pp book.

Engineering Office Equipment

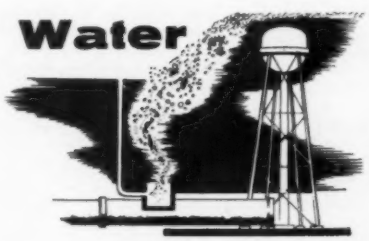
344 Drafting Pencils — A variety of pencils and other items for drafting and reproduction work are featured in this 24-pp catalog released by J. S. Staedtler, Inc. Includes pencils for work on drafting film, for color coding on tracings, non-reproducing pencils for making temporary work notes on drawings.

345 Typing Engineering Symbols — A method of using an electric typewriter for quick, convenient typing of special symbols and equations needed in the field of engineering is the subject of this 8-pp bulletin of Sperry Rand Corp.'s Remington Rand Div.

346 Reproduction Materials — Drawing and document reproduction material of Eastman Kodak Co. are featured in this 20-pp bulletin. A reproduction materials selection chart lists a variety of reproduction jobs, type of equipment to be used and materials needed.

347 Facts About Microfilm — "Let's Take a Positive Look at Microfilm" is an article reprint offered by Minnesota Mining and Mfg. Co. discussing merits of using microfilm as an active tool of business and industry. Applications shown.

348 Keep It Clean — How to clean and protect engineering drawings is told by Keuffel & Esser Co. in this 6 pp folder. Describes cleaning aides and protective spray, giving ordering information, prices.



349 Water Requirements Calculator — With this calculator you can quickly figure conversion of ppm water hardness to grains per gallon hardness, amount of exchange resin needed, brine and salt requirements, and brine tank size and operating brine level adjustments. Calculator, prepared by Morton Salt Co., can also be used in selecting tank size.

350 pH and Chlorine Control — The 16th edition of W. A. Taylor Co.'s handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and test kits are illustrated. Methods are also outlined for quantitative analyses. Available to qualified power engineers, please state your job title.

351 Boiler Water Treatment — Chemical reduction of oxygen in boiler feed water with hydrazine is the subject of 10-pp Bulletin BW of Fairmount Chemical Co., Inc. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details covered.

352 How Corrosion Attacks — In this data sheet, Betz Laboratories, Inc., explains how and why boiler, cooling and process water systems are constantly plagued by corrosion. Discusses such factors as pH, dissolved solids, temperature, flow rate, dissimilar metals, CO_2.

353 Automatic Treatment Control — Methods for automatic control of water treatment plants are discussed in 8-pp Technical Reprint T-179 by Graver Water Conditioning Co. In two parts, Part I deals with control of demineralization plants and covers "stepless" regeneration, regeneration, quality control of effluent, conductivity pH control, automatic regeneration. Part II considers control of cold process softening and clarification units, hot process-hot zeolite systems and sodium zeolite systems.

354 Corrosion Control — Methods used in steam-condensate systems for control of corrosion are described in Process Bulletin B-6 from Nalco Chemical Co. It covers use of filming corrosion inhibitors and neutralizing amines for low, medium and high makeup systems. Illustrations show how the inhibitors form a protective film and the amines neutralize CO_2.

355 Water Treatments — Three protective water treatments are described by Western Chemical Co. in this product bulletin. Details on potable water treatment, sweet water treatment and brine treatment are included.

356 Factors in Tube Failures — Available from Dow Industrial Service, Div., The Dow Chemical Co., is an 8-pp technical paper, "The Role of Copper and Physico-Chemical Factors in Steam Generator Tube Failures." Discusses physical factors contributing to localized deposition, presence of copper, suspended solids, interior tube projections, surface imperfections, differential thermal cells, copper removal, field usage of an additive.

357 Packaged Demineralizers — Illustrated and described in this 6-pp bulletin by The Permutit Co. is a line of packaged demineralizers, including mixed-bed demineralizers, two-step demineralizers, non-regenerable demineralizers and special skid-mounted units.

358 Water Softeners — Design and operation advantages of their high-capacity water softeners are detailed by The Permutit Co. in this 6-pp bulletin. Includes dimensional data and recommended specications for water softening system.

359 Sodium Zeolite Softeners — Described in 12-pp Bulletin 4520 by Cochrane Corp. is the sodium zeolite process of water softening. Includes information on selecting and sizing of equipment, automatic vs manual controls and calculations of softening capacity.

360 On Zeolite Softeners — "Care and Operation of Zeolite Softeners," covers bacterial fouling, deposits encountered and operational factors in relation to this equipment. Prepared by Betz Laboratories, Inc., it tells too, how exchange material should be handled to maintain maximum efficiency.

361 Treatment Instrumentation — Provided in 30-pp Booklet D97-2 of Minneapolis-Honeywell Regulator Co. is a compilation of article reprints on instrumentation for treatment of water and sewage. What instruments are used, how they are used and their functions in controlling automatically the many variables encountered in the treatment process are covered.

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362 Water, Sewage Treating — Water, sewage and industrial waste treatment equipment of Link-Belt Co. is described in 20-pp Book 2617. Illustrates equipment and shows flow diagrams of installations in typical water, sewage, and waste treatment plants.

Metals

363 Steel Weight Tables — This 72-pp booklet, released by Jos. Dyson & Sons, Inc., contains weight tables of steel, including weights of round, square, hexagon, octagon, and flat steel bars in a wide range of thicknesses. Also includes decimal equivalents, tables of area and circumferences.

364 Using Specialty Steels — Offered by The Carpenter Steel Co., this 40 pp guide to selection of specialty steels contains information on tool and die steels; stainless steels; high temperature alloys; electronic; magnetic and electrical alloys; special purpose alloy steels; tubing and pipe, fine wire specialties. Includes tool steel selector chart.

365 Ferrous Metallurgy — "Basic Guide to Ferrous Metallurgy" is a four-color chart prepared by Tempil Corp. showing principal characteristics of steels (with carbon content ranging to 0.9 per cent) across the temperature range to 1900 F. Important working zones including preheating for welding, stress relieving, normalizing, annealing, carburizing and forging are shown.

366 Steel Analysis — In this 20-pp pocket-size booklet, Jones & Laughlin Corp. lists compositions of 40 stainless steels, 184 alloy steels and 105 carbon steels most often used in industry. It also contains federal specifications with corresponding SAE, AISI and AMS numbers.

Safety

367 Fire Control Tips — This fire control chart, AD3003R8, shows fire extinguishers and gives detailed information including ratings. Prepared by Walter Kidde & Co, Inc., gives data on Class A, B and C fires and suitable extinguishers.

368 Fire Alarm Systems — Publication 246 of The Standard Electric Time Co. contains 36 pp of detailed information on fire alarm systems for critical applications in industrial, institutional and other public buildings. Contains typical job specifications covering all systems.

369 Handling Flammable Liquids — Problems involved in use of flammables and methods and equipment required for safe control are described by The Protectoseal Co. in this 76-pp safety handbook. Physical properties and characteristics of most commonly used flammables are detailed, and recommendations for safe handling of these liquids given.

371 Fire Extinguishing Equipment — Shown by Ansul Chemical Co. in 20-pp Catalog 1960 are hand portable extinguishers, stationary fire equipment, piped systems, and large capacity mobile equipment such as fire jeeps and trucks. Capacity data on various types of extinguishers and other equipment presented.

372 For Fire Protection — Folio 1 of Chemetron Corp.'s Cardox Div., is a 12-pp revised booklet on fire extinguishing systems and equipment. Lists principal causes of large-loss fires, advantages in use of carbon dioxide, and examples of extinguishing installations in steel, general manufacturing, electrical and other industries. Shows typical systems for protection of generators, flammable liquids.

374 Special Fire Protection — Devoted to special hazard fire protection, this 44-pp booklet of Grinnell Co., Inc. covers both equipment and methods. Tells how to recognize special fire-hazardous conditions in a plant. Discusses major types of fire protection, telling how each functions, giving it advantages and limitations.

375 Fire-Retardant Paints — Twelve-pp pocket-size Bulletin 100 of The Albi Mfg. Co., Inc., tells how fire-retardant paints reduce potential fire damage. Explains significance of the "safety margin" of extra time at start of a fire as related to protective action of paints on combustible building material, structural metal.

377 Color for Safety — Offered by Valdura Heavy-Duty Paint Div., American-Marietta Co., this 6-pp booklet shows a cutaway section of a typical industrial plant with all danger areas painted in appropriate safety colors. Lists recommended colors for every safety application.

379 Self-Sticking Identification — Products designed to aid in industrial maintenance and safety identification programs are illustrated and described in 32-pp Catalog 520 of W. H. Brady Co. Covers piping marking systems, identification of plant wiring and electrical equipment, lubrication marking, marking for hazardous areas and equipment.

380 Markers, Signs — Illustrated in full color, this 24-pp catalog of North Shore Nameplate Div., Anodyne, Inc., provides information on pipe and electrical markers, numerals, letters, safety and identification signs all available from stock. Explains how markers are applied, also includes prices, ordering information.

381 Personal Safety Equipment — Catalog 59, 76-pp, of Wilson Products Div., Ray-O-Vac Co., covers four general types of personal safety equipment: eye protective wear; respiratory protection; hearing protection; and headgear. Detailed production descriptions show individual components and parts, and charts recommend specific equipment for each hazard.

382 Equipment for Linemen — This 32-pp catalog of Charleston Rubber Co. describes high voltage rubber protective equipment for linemen, giving instructions as to its proper care and use. Also lists technical reports available, including a glove care poster, and provides a glove selector chart. Among products featured are gloves and sleeves, danger flags.

Lighting

383 Lighting Maintenance Tips — Principles and advantages of good lighting practice are presented in Champion Lamp Works' 48-pp lighting maintenance manual. Includes guide to trouble shooting fluorescent installations, tips on planning group lamp replacement cleaning.

384 Group Relamping Plan — Eight-pp Booklet A-6832 describes a group relamping plan designed by Westinghouse Electric Corp. to reduce costs, provide better lighting, and cause fewer work interruptions. Sample calculations provide data for setting up a schedule.

386 Floodlight Data in Brief — Pocket-sized Bulletin 2714 is a 184-pp miniature edition of Crouse-Hinds Co.'s floodlight catalog, and includes all original material. Covers selection of floodlights, general purpose floodlights, heavy duty models, mercury vapor floodlights, special types, lighting for hazardous locations, searchlights, poles, accessories. Includes installation tips, lighting calculations.

387 On Floodlighting — Bulletin GEA-7201, 10-pp, stresses value of good floodlighting, and gives application data and product information on filament, mercury vapor and fluorescent units. Photos show typical applications. A publication of General Electric Co., also tells how to get more light per dollar.

388 Area Floodlighting — Planning for lighting of parking areas and other open areas is detailed by Crouse-Hinds Co. in 16-pp Bulletin 2719. Contains reference guides for selecting incandescent or mercury floodlights, general purpose or heavy duty types, and for determining how many floodlights are needed.

389 Lighting Specifications — Included in the 52-pp RLM Standard Specifications are three new specifications for 1500 ma units: D-4 fluorescent semi-direct medium high mounting, SD-3AL semi-direct aluminum, and SD-3PE semi-direct porcelain enamel units. The book contains many upward revisions of existing specifications, and new specifications for aluminum reflectors. Booklet is prepared by The RLM Standards Institute, Inc.

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390 Modern Lighting Needs — "Footcandles in Modern Lighting," is General Electric Co.'s 20-pp revised booklet giving lighting level recommendations for seeing tasks involved in hundreds of industrial and other activities. Figures are based on findings of Illuminating Engineering Research Institute and Illuminating Engineering Society.

391 Incandescent Lighting — The 24-pp "Incandescent Lighting Guide Book" of Sylvania Electric Products Inc., features sections on the general advantages of incandescent lighting, the history of incandescent lamp developments, and includes chapter on basic types, bulb shapes, sizes, glass types and finishes, and bases.

392 Lighting Equipment — Illustrated and described in this 34-pp ring-bound lighting equipment catalog is The Wakefield Co.'s line of luminous ceilings, industrial fluorescent units, incandescent and mercury vapor units and other types of fixtures. Includes photometric reports, coefficients of utilization, mounting diagrams and specification points.

Another Reference File of Commercial Literature is in preparation and will appear in a few months. The editors welcome your suggestions for making this department of greatest value to you

394 Lamp Ballast Service — Described by Universal Mfg. Corp. in this product bulletin is a service program for fluorescent lamp ballasts which provides immediate replacement of inoperative ballasts. Also described is a 24-hr engineering service for design consultation, installation assistance or trouble-shooting.

396 Miniature Lamp Data — This 24-pp pocket size booklet of Chicago Miniature Lamp Works lists standard miniature lamps now available, and the sources of supply. Specifications of lamps (nearly 400) are given, also lamp nomenclature.

Materials and Maintenance

397 For Roof, Wall Construction — Included in this literature file offered by Elwin G. Smith & Co., Inc. are product bulletins describing roof and wall construction materials. Bulletin 59C covers corrugated sheets; 59W, insulated walls and metal panels; 595, insulated sandwich curtain walls and roofs; Bulletin 60D, steel and aluminum roof deck; Bulletin 60F, high-strength permanent steel forms for concrete roof and floor slabs; and Bulletin 60R, conveyor hoods and curved corrugated sheets.

398 Watertight Masonry — Major considerations in designing tight masonry walls are covered by The Master Builders Co. in 6-pp Bulletin O.M.-8A. Discussed are mortar ingredients and proportioning, compatibility of brick and mortar, control of shrinkage and bleeding, separation cracks, effect of mechanical disturbances.

399 Aluminum for Architecture — Comprehensive information on aluminum alloys and surface finishes is provided by Olin Mathieson Chemical Corp. in this 20-pp. booklet. Contains guides to mechanical finishes, as well as descriptions of textures, bright or satin surfaces. Electrochemical and chemical finishes with recommended coating for varying architectural exposures are listed.

400 Concrete Form Hardware — Comprehensive engineering data on concrete form hardware for large dam and other concrete constructions is presented in this 68-pp manual by Williams Form Engineering Corp. Among the forms and forming accessories covered are Vibra-Lock clamps, tie rods, anchors, hex-locks and hex-nuts, beam hangers, rubber control joints, rock anchor prestress. Pictures of typical dams, and heavy constructions included, along with load charts.

401 Handbook on Waterstops — In the 24-pp Kwik-Seal Waterstop Technical Manual of The Gates Rubber Co. is a wealth of practical information on waterstops and their use. Covers size and shapes of the waterstop, comparative data for rubber and plastic types, handling and storage of the material, design data for both "little" and "considerable" movement joints, application data.

402 Grouting Methods — Effective methods for grouting the different basic types of heavy industrial equipment are explained with text and photos by The Master Builders Co. in 8-pp Bulletin EPMG-2A. Advantages of the pre-mixed grout are explained, and diagrams, charts and photos cover preparatory steps, forming, selecting materials, mixing, placing.

403 Safety Grating — Steel, aluminum and stainless steel safety grating for a variety of industrial applications is featured in illustrated 24-pp Catalog 5911 offered by The Globe Co. Shows typical installations, and includes engineering data for erection, load charts.

404 For Masonry Anchoring — Catalog 25 is a 48-pp pocket-sized handbook of anchoring and drilling devices produced by The Rawlplug Co., Inc. for fastening anything to masonry. Includes tables showing proper anchors for each type of fixture and material.

405 Masonry Fasteners — Fifty-pp pocket-size Catalog 160 of Diamond Expansion Bolt Co., Inc. lists anchors and fasteners for masonry and hollow walls. Covers machine screw anchors, lag screw expansion shields, machine bolt expansion shields, closed back machine bolt expansion shields, masonry drills, anchors.

406 Wire Rope Slings — Detailed information on wire rope slings made by The Colorado Fuel and Iron Corp. is presented in this 84-pp product catalog. Each major type of sling is described, complete with illustrations and charts, and selection details and basic rules of hitching included.

407 How to Use Wire Rope — Comprehensive information on use and abuse of wire rope is presented in this pocket-size 92-pp manual offered by Macwhyte Wire Rope Co. Covers selection of wire rope, constructions, capacities, maintenance and lubrication, breaking-in of wire rope, approved methods of seizing wire rope, wire rope attachments.

408 Heavy-Duty Electric Tools — Twelve-pp Condensed Catalog G20, Milwaukee Electric Tool Corp., illustrates and describes heavy-duty electric tools, including drills, saws, shears, hack saws, generators, grinders, hammers, screw drivers, nut runners, sanders and polishers.

409 Tool Buyers' Guide — Catalog 60, complete with specifications and prices, is a 68-pp ordering book on Double Circle tools of Chicago Latrobe. Covers drills, reamers, end mills, countersinks, carbides, counterbores, others. Also provides information on features and applications; includes section on drill facts.

410 Grinding Wheel Chart — Information contained in this chart is based on rules and regulations established by the American Standard Safety Code for use, care and protection of abrasive wheels. Prepared by the Grinding Wheel Institute, it lists "do's and don'ts" of wheel care.

411 Tips on Grinding Wheels — Over 1600 abrasive wheel recommendations for grinding everything from agate to zirconium are set up in alphabetical order by The Carborundum Co., in this specification catalog, about 57-pp. Material, work, operation — with their respective recommendations on abrasive, grit, grade and bond — are listed.

412 Pipe Fitters Manual — Information expected to be at the finger tips of pipe fitters and pipe welders is concentrated into this 72-pp fitters manual offered by Tube Turns Div., Chemetron Corp. Text, tables and illustrations in the pocket-size handbook give important mathematical, physical, chemical and metallurgical data and related design, layout and mechanical information.

413 How to Bend Conduit — This 12-pp pocket-size booklet of Appleton Electric Co. gives instructions for making precision bends in electrical metallic tubing, rigid steel, and rigid aluminum conduit. Covers five fundamental bends — angle bends, stub lengths, back-to-back bends, offset and three-bend saddles. Diagrams show techniques for on-the-spot bending of small conduits.

414 Brazing Techniques — This 24-pp manual contains data for brazing shapes, sheet, castings, tubing and assemblies of aluminum, cast iron, copper, brass and steel. Covers such basic functions as heat, flame and torch settings, alloys selection and joint design. Solutions to common brazing problems are answered by All-State Welding Alloys Co., Inc.

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415 Conduit Bending — Illustrated Bulletin 260, on bending conduit or pipe easily and accurately, features an improved bender. Prepared by Lidseen of North Carolina, booklet covers calculating lengths of legs, locating bend, back-to-back method, back-to-back push-through.

416 Soldering Tools — Catalog S-60 of Ungar Electric Tools contains 8 pp of detailed information on soldering tools featuring interchangeability. A temperature chart for various applications is included.

417 Guide to Preheat — Welding of low-alloy high-tensile steel and other alloy steels with the aid of preheat is explained by J. B. Nottingham & Co., Inc., in 40-pp "A Guide To Preheat." Physical and chemical changes that take place in these problem steels during and immediately after welding are outlined.

418 Equipment for Welding — Gas welding, cutting and allied equipment of Smith Welding Corp. is covered in this 40-pp manual. Book is arranged in six sections. Charts and technical data are provided. One section covers flow capacity curves for gas pressure regulators.

419 Arc Welding — Basic information concerning arc welding techniques for small diameter piping is contained in Lincoln Electric Co.'s Bulletin 2112.3. Lists advantages of welded piping installations; describes procedures, explaining calculation of welding costs. Recommends suitable types of electrodes.

420 Welding Data — This 148-pp pocket-size maintenance welding data book, issued by Eutectic Welding Alloys Corp., provides a guide, indexed by application, to nearly 200 rods, electrodes, and chemical aids. It illustrates and explains general welding techniques and joint design hints, and covers elimination of warping, distortion, embrittlement and other base metal damage; wear, impact and corrosion resistance.

421 Vest Pocket Welding Guide — This revised edition of "How to Get Better Welds," published by Hobart Brothers Co., contains 80 pp of arc welding information. Covers essentials for proper welding procedures, good and bad welds, welding positions, operator qualifications, welding metals and steel available for welding. Also deals with causes and cures of common welding troubles, check points for quality welding, cost saving, safety.

422 Tips on Welding — This 56-pp welding, brazing and soldering alloy and flux catalog and instruction manual issued by All-State Welding Alloys Co., Inc. covers physical properties, major uses, detailed application instructions and latest techniques for welding, brazing, soldering, cutting and hardfacing.

423 On Welding Electrodes — Contained in this 64-pp electrode pocket guide of Air Reduction Co., Inc. is information on all types of electrodes including mild steel, low alloy, low hydrogen, iron powder, stainless steel, hardfacing, non-ferrous and cast iron. Covers applications, procedures and pertinent data on each electrode, includes charts of electrodes for welding various steels, and tables for mild steel and hardfacing electrodes.

424 Manual Welding Equipment — Described in 20-pp Catalog F-8982E is Linde Co.'s manual welding equipment using an inert gas to protect the weld zone from the atmosphere. Various types of welding torches and accessories for welding of commercial metals covered.

425 Chemical Cleaning Services — Specialized cleaning facilities offered by Dow Industrial Service, Div., The Dow Chemical Co. are detailed and illustrated in 8-pp Form 1. Services, available on nation-wide basis to utilities, chemical plants, refineries, paper and steel mills etc., include chemical filling, cascading, foaming, jetting, acid steaming. Bulletin explains how company's own crew brings necessary equipment into your own plant and handles entire job.

426 Powdered Acid Cleaner — Bulletin HSP-940 describes a powdered acid cleaner, made by Hagan Chemicals & Controls, Inc., for use in cleaning scale deposits from boilers, heat exchangers, water lines, pumps and other equipment. Advantages are listed and possible methods of application outlined.

427 For Chemical Cleaning — Technical Bulletin 102, about 16-pp, presents application and other information on products of Chas. Pfizer & Co., Inc. for chemical cleaning. These include formulas for power plant cleaning, stainless steel cleaning, aluminum and aluminum alloy cleaning, alkaline derusting and paint stripping, general cleaning, others.

428 Painting Galvanized Steel — Effective techniques for painting galvanized steel sheets, are explained in this 16-pp booklet, produced jointly by the American Iron and Steel Institute, the American Zinc Institute, and the National Paint, Varnish and Lacquer Ass'n. Discusses main reasons for this painting: appearance, heat reflection, longer service.

429 Paint Economy — Factors to consider in selecting paints are detailed by Barreled Sunlight Paint Co. in this sixth edition of "Engineered Color," a 20-pp specifications catalog. Covers proper use of paint and color, requirements of various surfaces, color and the safety program. Describes interior and exterior primers and finishes, varnishes and floor sealers, and includes color chips.

430 Aluminum Paints in Color — Protective and decorative advantages of painting with aluminum in color are discussed by Aluminum Co. of America in Form 30-11451. Illustrated in full color, shows examples of use of this metal-bright paint on industrial structures.

431 Protection Against Rust — This 38-pp treatise (Form 259) on rust and corrosion control by protective coatings shows actual color standards of Rust-Oleum Corp.'s primers and top coatings. Covering water resistant, heat resistant floor coatings, heavy-duty chemical resistant coatings, galvanized metal coatings, wire fence roller coatings, and quick-dry coatings. Bulletin contains full-color application photos and 110 color chips, and technical section giving data on surface preparation application.

432 Masonry Treatments — Water-proofing, protective and corrective treatments for masonry are described by Standard Dry Wall Products, Inc. in 22-pp Circular 17. Discusses products and uses. Includes application photos.

433 Efflorescence, Chalking — Causes of efflorescence and early chalking on painted masonry surfaces, and ways to overcome and prevent such deterioration are explained by Rohm & Haas Co. in this 48-pp booklet. Discusses paint formulation and compares four major types of emulsion vehicles for resistance to alkali, moisture, heat, and ultra-violet light. Also covers film swelling, film coalescence, paint stability in presence of soluble salts.

Packings, Seals, Gaskets

434 Packing Chart — This packing recommendation chart by Raybestos-Manhattan, Inc., shows basic packing types for 95 per cent of all packing needs. Covers such applications as: pumps and valves, high-temperature valve stem and expansion joints, high-speed rotary air compressors, corrosive and viscous liquids, chemicals, gasket applications, and hydraulic and pneumatic equipment.

435 Mechanical Packing Guide — Johns-Manville's 64-pp catalog, Form PK-131A, contains comprehensive information on mechanical packings. Includes chemical selection chart listing more than 700 liquids common to process industries. Also featured is a simplified selection chart to help relate operating conditions to most suitable packing.

436 Mechanical Packings — Catalog P-210C, Raybestos-Manhattan, Inc. contains 40 pp detailed information on machanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations.

437 On Boiler Gasket Leakage — Some causes of boiler gasket leakage are discussed in Technical Paper 139 by Betz Laboratories, Inc. Factors to consider in overcoming or minimizing gasket leakage, such as selection of gasket joint, installation, and corrosion protection, are explained in detail.

438 O-Ring Handbook — Catalog 5711 is a 24-pp design and data book of Parker Seal Co. on Viton O-rings. Contains test information on some 150 fluids and gases to which this synthetic elastomer is compatible; recommended design techniques; general information on three compounds; data on all standard sizes.

439 Corrosion-Resistant Seal — Information and engineering data on a corrosive service shaft seal made of Teflon and designed to handle all concentrations of acids and salts, strong oxidizing or reducing agents and organic compounds are contained in Bulletin S-233 of Crane Packing Co. Table of operating pressures and temperatures is included.

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440 Corrosion Resistance Chart — Over 150 chemicals and their recommended uses with ductile iron, iron, steel 316 and 304 stainless steel, Monel, brass, bronze, copper, aluminum and plastisol plastic are listed in Corrosion Resistance Chart J-CRC. Prepared by OPW-Jordan Corp., chart shows which gasket materials are needed when Kamlok couplers are used and which O-ring materials are needed when swivel joints are used.

Automation, Instruments and Controls

441 Automatic Controls — Comprehensive data on mercury-switch equipped controls for single-stage pressure, two-stage pressure, differential pressure, single-stage temperature, two-stage temperature, liquid level and mechanical movement are presented by The Mercoid Corp. in 56-pp Catalog 860. Specifications and engineering data provided.

442 Industrial Controls — This 88-pp catalog presents comprehensive information on controls, offered by General Controls Co., including automatic temperature, pressure, level and flow controls, as well as counters, switches and automation controls. Other items described are industrial actuators, combustion instrument controls, controller indicators and pressure indicators.

443 Telemetering Systems — Metameter telemeters for remote measurement, recording and automatic control are described in 52-pp Bulletin M1715 of The Bristol Co. Covers principles of operation, types; application to various factors including pressure, water level, temperature, flow, motion and position; and electrical quantities.

444 Temperature Controls — Filled with charts, drawings and diagrams, 24-pp Bulletin 101, of the Partlow Corp., discusses industrial temperature measurement and control, including ways of responding to temperature, ways of putting temperature response to work, mercury-bulb instrumentation, basic types of controls, and a score sheet for the mercury-bulb system. Also covers basic concepts of control instrumentation.

445 Instruments and Controls — Catalog 57-6, Republic Flow Meters Co., describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorder, temperature recorder and others.

446 Controls, Gages — Comprehensive information on controls and gages for use on dust collectors, air filters, boilers and furnaces, ovens and dryers, air conditioning systems, fans and blowers is presented by F. W. Dwyer Mfg. Co. in this ring-bound catalog, Sections A through S. Separate sections cover magnetic pressure gages, inclined and vertical manometers, pilot tubes, air filter gages, manometers, pressure actuated switches, flowmeters, combustion testing instruments.

447 Draft Gages, Instruments — Bulletin 354-B is a condensed catalog of Ellison Draft Gage Co., Inc., covering stationary and portable draft gages, pitot tubes, air filter gages, gas analyzers, steam calorimeters.

448 How to Select Recorders — Buying information on recording instruments of General Electric Co. is provided in 12-pp Bulletin GEA-6933, including dimensions and chart speeds, operating specifications, applications, features and accessories. Also described are specialized instruments — recording vibrometers, automatic oscillographs.

449 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft, Dura-gauges, Maxisafe, pneumatic receiver, recording, drawn case, chemical and special application gages of Manning Maxwell & Moore, Inc. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in.

450 Pressure Gages — Featured by J. E. Lonergan Co. in 46-pp Catalog 1000G are pressure indicating and vacuum gages for industrial, chemical, and refinery applications. Selector tables give data on various gages and recommended services. Specifications, standard graduation tables, photos, dimension diagrams included.

451 Hydrostatic Instruments — In this 88-pp pocket-size handbook of hydrostatic instrumentation, Petrometer Corp includes information on principles of hydrostatic measurement, selection and installation of instruments, design and construction of panel systems, as well as engineering data and diagrams. Provides tank volume formulae, conversion tables, viscosity charts, hydrometer scales, specific gravity tables for various liquids.

452 Laboratory Instruments — Illustrated and described in 12-pp Bulletin 757 is a line of pH meters and other electrochemical instruments. Also covers ultraviolet, visible, and near-infrared spectrophotometers, and describes typical applications. Scientific and Process Instruments Div., Beckman Instruments, Inc.

453 Recording Type Controller — Bulletin 335, issued by Stickle Steam Specialties Co., describes recording type controllers designed to maintain desired pressure or temperature of steam or liquids. Table of dimensions included.

454 Test Instruments — Catalog G-10 contains 48 pp of data on measurement, recording, and testing instruments of Minneappolis-Honeywell Regulator Co. Covers are d-c amplifiers, data handling systems, calibration instruments, magnetic tape instrumentation, nuclear instrumentation, oscillographs, recorders and indicators, servo components, temperature controllers, transducers.

455 Electrolytic Conductivity Equipment — Laboratory conductivity bridges and cells are described by Industrial Instruments Inc. in Catalog 24. Table gives individual listing of standard conductivity cells, showing cell constant and type of construction.

456 Control Products — Special applications of flow switches and controls are detailed by McDonnell & Miller, Inc. in 22-pp Bulletin ERS-A. Describes flow switches for chilled water systems, condenser cooling water systems, stand-by pump operations, for starting automatic burner on hot water supply systems, controls for open expansion tanks, for compression tanks, for oil storage tanks, high water alarms and other functions.

457 On Thermocouples — Detailed information on thermocouples and thermocouple components and accessories is contained in 50-pp Catalog EN-82 of Leeds & Northrup Co. Lists and describes standard assemblies in protecting tubes and wells for general applications; specialized thermocouples and assemblies; and bare and insulated thermocouple wires, replacement elements, protecting tubes.

458 Automatic Controls — Selection and application information on automatic controls for steam and water service is presented by The Powers Regulator Co. in 46-pp Engineer's Manual. Covers controls for fuel oil heaters, heat exchangers for cooling, instantaneous heat exchangers, jacket water cooling, process hot water, pressure reduction, storage heaters.

459 Timers and Counters — Condensed Catalog D-31 contains 30 pp of reference data on automation components and control systems, covering latest timing components and linear measuring systems. Standard timers and counters are reviewed as well as electronic timers, package control systems, test equipment, switches, controllers, other products of Automatic Timing & Controls, Inc.

461 Sensing Device — Described in Bulletin RI-1825 is a leakproof sensing device for detection and control of process variables. Advantages and applications are detailed and operation principle of W.I-T (wire in tube) element given. Yarnall-Waring Co.

462 Steam Temperature Control — Operation and control of high steam temperatures is described in Bailey Meter Co.'s Bulletin 543. Three detailed diagrams explain principle of desuperheater water control and burner tilt and desuperheater water control.

463 Automatic Colorimetric Analyzers — Applications of automatic colorimetric analyzers are described by Milton Roy Co. in 8-pp Bulletin 1156-2. Includes detailed specifications and operation information.

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464 Mass Flowmeter — Bulletin GEA-6925, 8-pp, describes theory, operation and advantages of General Electric Co.'s flowmeter that measures flow of fuels, industrial liquids, and gases directly in pounds. Gives ranges, specifications.

465 Leak Detector — Instructions on use of halogen leak detectors for finding leaks in enclosures that can be pressurized, in such applications as steam boilers, valves, piping, transformers, air-conditioning and refrigeration equipment are given by General Electric Co. in Bulletin GET-2936, 6 pp. Discusses system preparation, testing procedures, calibration.

466 Boiler Cleaning Control — Details on automatic boiler cleaning control systems are presented by Diamond Power Specialty Corp. in 14-pp Bulletin 2148. Includes specifications on standard control panels and shows some possible combinations, as well as custom-built control panels designed for specific applications.

467 Tube Rolling Control — Featured in Bulletin AC-74, The Gustav Wiedeke Co., is an automatic torque control for tube rolling which operates off standard reversible electric drills or tappers, for controlling expansion on tubes ¼-through 4-in. diam. Advantages are noted, accessories described.

468 Nuclear Instrumentation — Detailed information on nuclear instrumentation and accessories is presented in 50-pp Condensed Catalog F of Tracerlab, Inc. Covers all phases of nuclear study and includes detectors, counting and radiation analysis equipment, sample changing equipment and necessary adjuncts for personnel protection, monitoring.

469 Turbine Instruments — Bulletin GEZ 3078-1, 12 pp, includes description and specifications of General Electric Co.'s compact redesign of a turbine supervisory instrument system that charts a permanent record of mechanical performance throughout starting and running periods. Detailed description of system's ability to monitor vibration, shaft eccentricity, shell and differential expansion, speed and valve position is included.

470 Boiler Level Controls — Operating principles of Magnetrol, Inc. boiler water level controls are explained in 16-pp Catalog Section 3. Features and typical functions of a number of models in the line are detailed along with switch mechanisms, construction details.

471 Data Processing at Work — Data processing equipment of Leeds & Northrup Co. now in use throughout the country is described in 48-pp Preliminary Technical Publication N-07(1). Installations covered include digital data processing and analog and digital computing systems. Explains types of inputs, input switching, output devices and modes of operation for applications in electric-power, petro-chemical, other fields.

472 Automation for Utilities — Automated equipment and systems for electric utilities are described in General Electric Co.'s Bulletin GEA-7044, 244 pp. All phases of system operation — generation, transmission and distribution — are covered, as well as automatic load dispatching covering the areas of load-frequency control and economic loading.

473 Fuel Cut-Out Controls — Bulletin D2.5 released by Reliance Gauge Column Co, describes float-operated and electrode-operated fuel cut-out controls combined in one device. It also describes a low water level alarm.

474 Annuciator Systems — Details on operation and use of annunciator system to provide continuous and automatic surveillance of pipeline, chemical and food processing, power generation and distribution is given by The Scam Instrument Corp. in 36-pp Catalog 659. Types of annunciator sequences are illustrated and described, annunciator diagrams included.

475 Alarm/Control System — Bulletin ECM 119, about 16 pp, of General Electric Co., describes a high-capacity alarm/control system providing an inexpensive method of locating faults at unattended operations and controlling on-off functions remotely. Tells how equipment can be "customized" to suit specific supervisory or control needs.

476 Annunciator Systems — Well illustrated with photos, charts and diagrams, 52-pp Catalog 100C of the Panalarm Div., Panellit, Inc., presents information on annunciator systems designed to give immediate notification of off-normal conditions in continuous process and automatic operations. Discusses function and applications of annunciators.

477 Computer Talk — This 22-pp glossary of "computerese" — the language of electrical brains — is compiled by Minneapolis-Honeywell Regulator Co. to make computer language more intelligible to the layman. Defines over 82 terms found in the vocabulary of computer engineers.

478 Alarm Indicating Monitor — Presented in 8-pp Bulletin MSP-195 by Hagan Chemicals & Controls, Inc. is detailed information on their alarm indicating monitor which combines all alarm functions in one instrument. Includes specifications and covers input selection, logic, amplifying, alarm detection and display, readout, scanning sequence presentation, alarm circuit check.

479 Teaching Servo Systems — A new method of teaching servo systems that bridges the gap between theory and practice is described in 8-pp Special Report SR-3 by Servo Corp. of America. Explains how packaged assembly of electronic and electrochemical components permits students to build and test servo systems, demonstrates formula derivation, characteristics of control systems.

480 Compiler-Translator — Act I, an electronic algebraic compiler and translator, is described in 18-pp Manual S-520 of Royal McBee Corp. Explains "source" program language — a series of algebraic and logical statements. Stresses simplicity of use, faster programming and thus faster computer solutions.

481 Signaling Equipment — Air and electric signal systems and specifications of horns, bells, buzzers, chimes and sirens are featured in 88-pp Catalog 160 by Sperti Faraday, Inc. Included are sections on gravity drop and lamp type annunciators and accessory equipment, and charts and diagrams for selection of proper type signal for various background noise levels and work areas.

Other Equipment

482 Sewage Lift Stations — Engineering data on Smith & Loveless factory-built sewage lift stations designed for underground installation is presented in this data manual. Includes complete specifications, job recommendations, installation instructions, detailed drawings, pump selection charts, operating instructions and list of typical installations.

483 Corrosion Data Charts — Corrosive effects of almost 400 different materials on 16 types of metals are shown in corrosion data charts contained in Technical Service Bulletin 101 issued by Nooter Corp. Charts indicate corrosion resistance of metals to various concentrations of chemical salts and acids, as well as common materials such as water, glue, fruit juices, salt, turpentine, others.

484 Scale Model Components — Vessels, heat exchangers and pumps of molded expandable polystyrene — model equipment which can be worked with knife or hand saw and can be sanded, glued, pinned or screwed — are featured in this 8-pp bulletin of Industrial Models, Inc.

485 Torque Manual — This 32-pp catalog is a recent revision of P. A. Sturtevant Co.'s popular torque manual. Includes application illustrations, bolt charts, discussions on assembly characteristics, instructions for torque wrench testing, pictures of modified and special torque wrenches, formulas and illustrated explanations for using adapters, attachments and extensions.

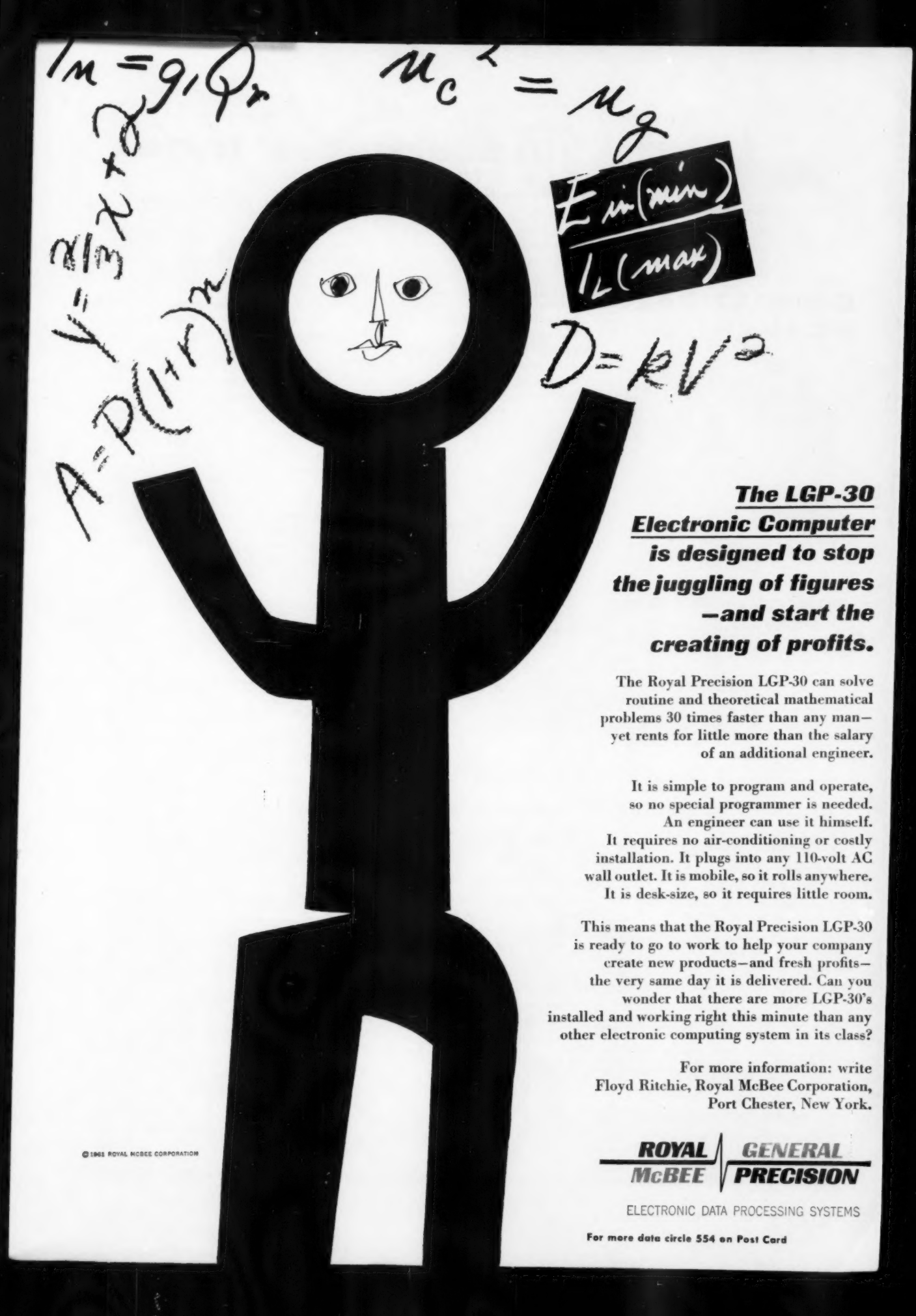
486 Where's the Coal — Peabody Coal Co. has issued a bulletin listing location of its coal reserves. A map shows location of coal reserves for most economical access to fuel supplies.

487 Cathodic Protection — Booklet describes corrosion control for buried or submerged piping, tanks, ships and similar structures. The company's consulting services, field surveys, design, installation and materials as well as general cathodic protection procedures are discussed in detail by Harco Corp.

488 Product Guide — Illustrated and described in Condensed Catalog 605 is Syntron Co.'s broad line of equipment for industry, presents electric vibrators, rotary vibrators, car shakers, vibratory feeders, mechanical vibrating conveyors, screening feeders, packers and jolters, hopper level switches, flow control valves, vibratory elevators, dry feeder machines, weighing equipment, electromagnetic vibrating screens, parts feeders, power rectifiers, battery chargers, mechanical shaft seals, and portable power tools.

490 94 Chemicals Reviewed — Organic and inorganic chemicals — 94 in all — produced by Hooker Chemical Corp. are reviewed in this 16-pp Bulletin 100-D. Gives factual information on 88 commercially produced products, six development ones, including 20 recently developed chemicals. Covers acids, alkalies, the elements chlorine and phosphorous, metallic salts, phosphorous and sulfur compounds, chlorides, chlorobenzenes, others.

Postage-free Readers Service Cards are on pages 103-104



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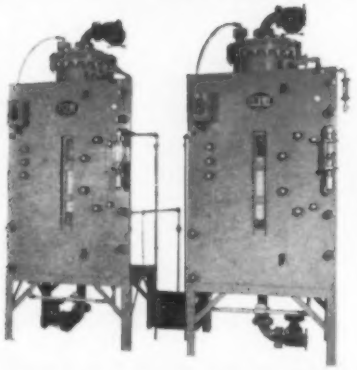
HIGH FLOW RATE

CONDENSATE SCAVENGERS



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You may know that some of the new, fantastic, super-critical, once-through power plant boilers use elaborate condensate-scavenging demineralizers. Since 1951, however, IWT has supplied *less complex* but highly effective and economical de-ionizers for condensate scavenging to various "conventional" power plants. These operate on a by-pass system, de-ionizing a portion of the total condensate stream, to produce a marked improvement in conductivity and silica in the boiler water and a corresponding reduction in costly blowdown. Initial investment and operating costs are modest.

"PACKAGED" FOR EASY INSTALLATION

The picture above shows a typical twin-condensate-scavenger installation consisting of parallel Mixed-Bed De-Ionizers. Each of these units is shipped fully-assembled, as a complete "package," with the tank, piping, valves and instruments all installed, connected, and tested. The tank is filled with resin and the unit is ready to operate. (U.S. Patents 2,605,084 and 2,771,424.)

CALL YOUR IWT MAN

Your nearest IWT Representative is equipped by experience to advise you well not only in the possible applications of these condensate scavengers, but also with respect to many other water-treatment problems.

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By the time most grating is erected, much of the normal factory-applied coating is worn off. Unless it is repainted at once, costly corrosion starts to take its toll.

However, "Ponbake," the new epon base, high polymer synthetic paint process, developed by Blaw-Knox especially for grating, stays factory-new almost regardless of the treatment it gets.

This is the most rugged, durable finish available on gratings today. It has greater resistance to wear, abrasion, corrosion, chemicals and weathering than any other. Costs less than on-the-job painting. Write if you would like more information, or ask for a Blaw-Knox Grating salesman to show you a sample.

Free facts on grating. Write for Bulletin No. 2581. Blaw-Knox Company, Pittsburgh 38, Pennsylvania.

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GRATING

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Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes Towers and Special Structures • POWER: Power Plant Specialties and Valves

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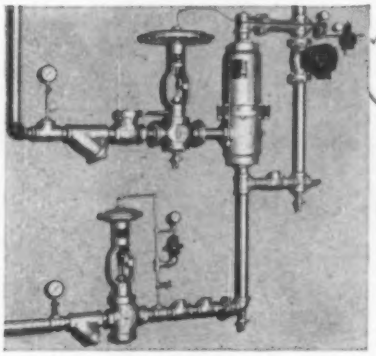

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WATER HEATERS

for high or low pressure steam

Direct contact of steam and water in the Pick patented mixing chamber produces hot water at the desired temperature, and in the required quantity, *instantly!* There's no time lag . . . no steam wasted to maintain heat in stored water . . . steam used only as hot water is drawn. Water temperature maintained within 3° plus or minus. Volume adjustable from 5% to full rated capacity. Pick heaters require no floor space . . . usually installed on wall. Whatever your hot water needs are, Pick will do it faster, more accurately and at lower cost!

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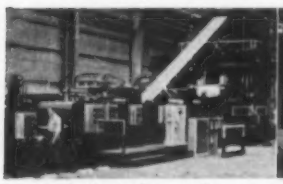
Used by America's Leading Industries:



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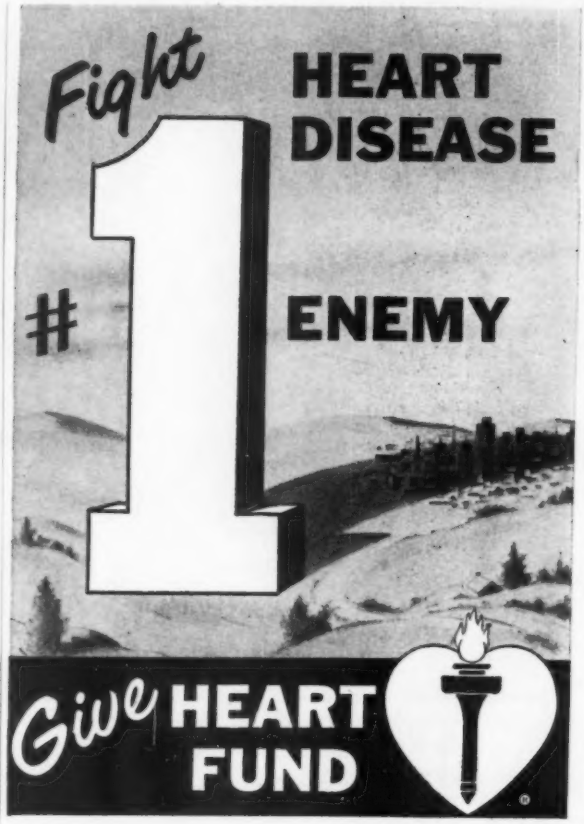
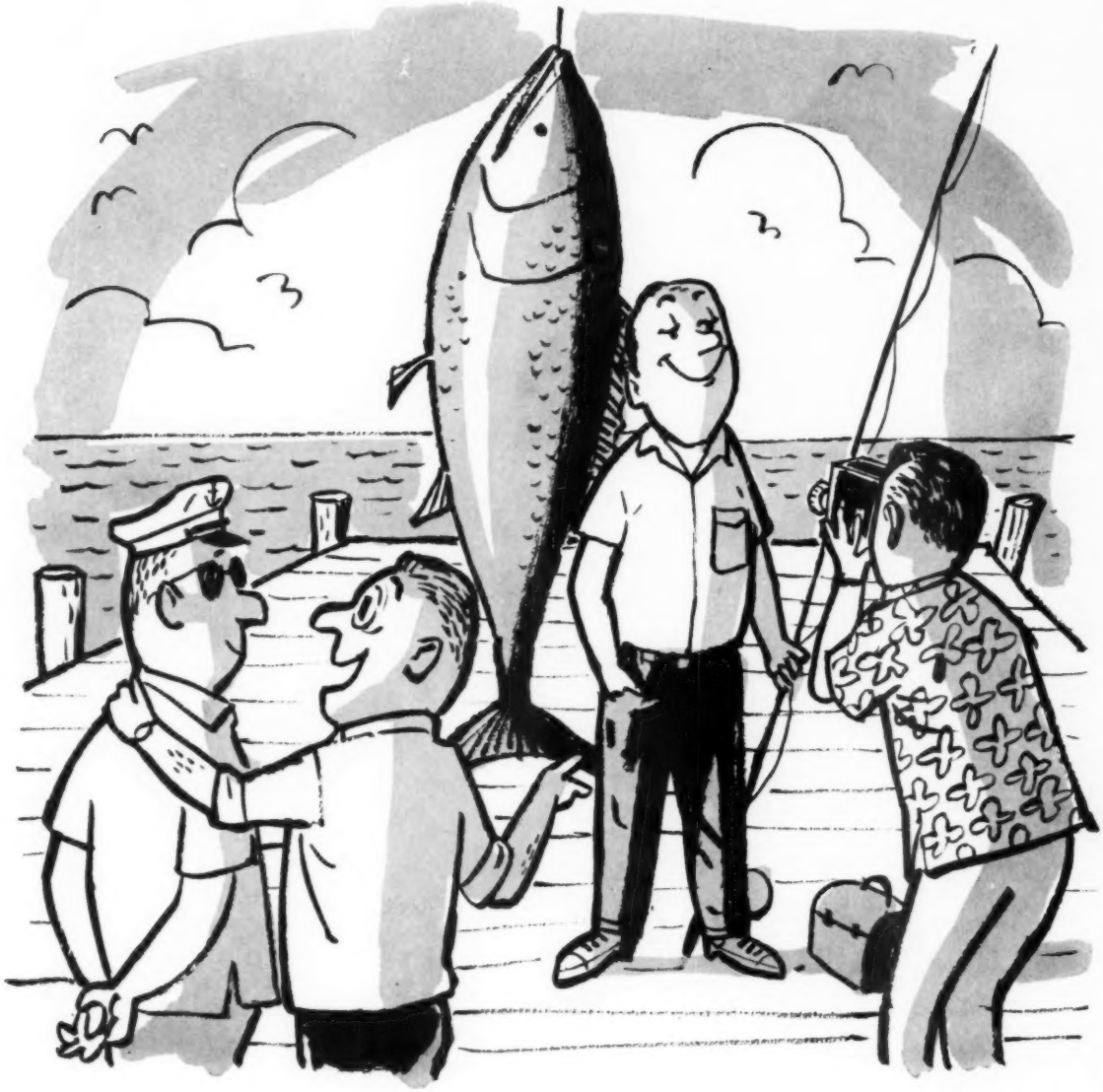


The easiest—and quickest—way to order bulletins and catalogs described in this magazine is to use the postage-free Reader Service Cards on pages 103–104.

All you need to do is circle the item numbers of those you want. Then fill in your name, job title, company name and address—and mail the card.

You may also use the Reader Service Cards to request information on products described, or literature mentioned in the ads—just circle the number below the ad.



"It's the same expression he had at the plant the day he discovered how to lower the cost per 1000 pounds of steam."

That proud feeling begins when you realize this: the coal that will produce the most efficient, most economical results in *your* burning equipment is coal *prepared* for your burning equipment. That's why ISLAND CREEK PRECISIONEERED COAL can so often reduce net steam costs. It's coal from superior southern seams, prepared scientifically to your exact specifications with precision engineering techniques and strictest laboratory controls. Write or phone to set up a discussion that may well lower *your* steam costs. No obligation, of course.

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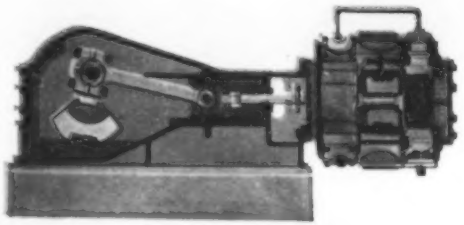


HIDDEN VALUES?

Are they all in Worthington Horizontal Compressors?

Frankly, they're not. And we're glad! One of the "hidden values" listed below we'd hate to sell—see if you can tell which one it is. (Correct answer on page 101.)

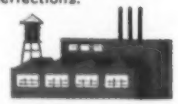
On the other hand, we're extremely happy to be selling horizontal compressors with the other 24 "hidden values" built in. (Not everyone does.)

Frankly, we could drop many of these and 99 users out of 100 might never know it. But the 100th could suffer untold expense . . . so we keep them all for everyone. To buy these "hidden values", please contact your local Worthington representative next time you specify a compressor. Worthington Corporation, Compressor and Engine Division, Buffalo, N. Y. 36-10

SALES AND SERVICE INTEGRATION recognizes kinship of one to the other. One man administers both.

MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.

ADJUSTABLE ROLLER MAIN BEARINGS feature low friction losses which help to extend compressor life.



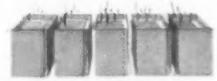
INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

FEATHER VALVE — industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

CAPACITY CONTROL —choice of simple by-pass, through dual to complex sequential control systems.

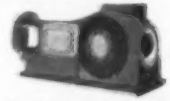
FLEXIBILITY — oil or non-lube; single or multi-stage; Worthington MVD, direct or geared drive.

ULTRASONIC TEST — an advanced method of examining certain critical parts for internal quality.



PARCO-LUBRITING of critical wearing surfaces completely eliminates most start-up scuffing problems.

ACCESSIBILITY — valves, packing and main parts are easily observed and reached by operators.



ONE-PIECE FRAME includes built-in housing with full foundation support to minimize stresses.

2000 CRAFTSMEN, these units built by same men who design and build large 5000 hp, 15,000 psi units.

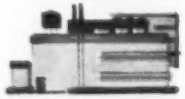
KOLENE PROCESS removes impurities from crankpin bearing shell that weaken bond to babbitt.

OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

FACTORY ASSEMBLY and shop run-in on air insure proper operation and reduce installation costs.

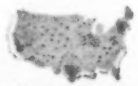
FINISHED GROUND BEARING SHELLS provide crankpin positive full-contact backing for long life.

COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.



$1,000,000 ADDITION TO LABORATORY assures sound equipment designs based on actual research.

COUNTERWEIGHTED CRANKSHAFT eliminates vibration and insures a smoother operation.



DISTRIBUTORS — over 200 in major markets give local supply and close contact with Worthington offices.

FULL-FLOATING WRISTPINS in piston give minimum piston and cylinder wear and reduce maintenance.

STOCKING PROGRAM standard air and gas gathering units are kept in stock to give short shipments.

PROFILOMETER inspection of highly finished parts assures easy break-in and long life.

THERMODYNAMICS SECTION analyzes special application to size unit and determines performance.

DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

WORTHINGTON